Compressed Air Magazine

METAL MESH TO FORM A CEILING

Unique Construction Feature At The Brussels Fair

SEPTEMBER 1958 NEW YORK • LONDON

Air Casualties

It's bad air that does it. But you can step up production by putting a Coppus Blower on the job to keep the air moving — and keep the men cool.

The kind of air a man works in has a lot to do with how much work he can turn out.

In confined places like shipholds or tanks or drums or boilers . . . or wherever the air is stagnant or hot or full of fumes . . . a Coppus Blower is a *must* for getting first-class work out of the men, all the time.

A Coppus Blower or Exhauster helps avoid sickness and lassitude due to bad air . . . and improves morale, too.

Portable and adaptable for special purposes, Coppus Blowers and Exhausters will have dozens of uses around your plant. The "Blue Ribbon" (a blue painted band) is your assurance of quality performance at lowest cost.

COPPUS

BLUE RIBBON BLOWERS

THE BLOWERS THAT PUT MORE MINUTES IN EVERY MAN-HOUR

CABLE MANHOLE AND TANK VENTILATORS — BOILER MANHOLE BLOWERS AND EXHAUSTERS — HEAT KILLERS — SHIPHOLD VENTILATORS . . . DESIGNED FOR YOUR INDUSTRY — ENGINEERED FOR YOU

MAIL THIS COUPON To Coppus Engineering Corp., 209 Park Avenue, Worcester 2, Mass. Sales offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in BEST'S SAFETY DIRECTORY.

PLEASE SEND ME INFORMATION ON SUPPLYING FRESH AIR TO MEN WORKING:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fuselages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.
- ☐ drying of walls, sheets, etc., after treated with coating material.

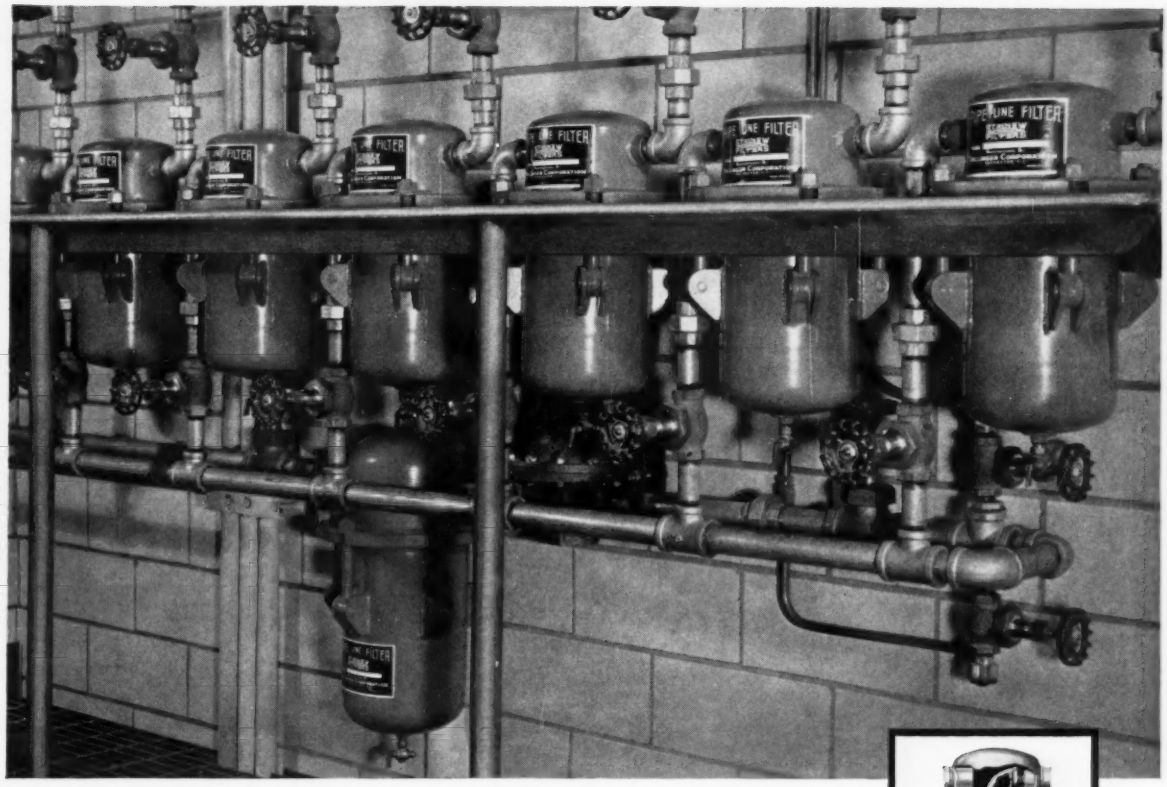
NAME.....

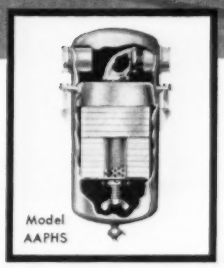
COMPANY.....

ADDRESS.....

CITY.....

(Write here any special ventilating problem you may have)





RG&E Standardizes with Staynew Filters

Successful Staynew filter applications abound at Russell electrical station of the Rochester Gas & Electric Corporation.

When Russell opened in 1949, the utility specified Staynew absorption filters, Model AAPHS, for supply air to its automatic boiler controls after coke and then charcoal filters had failed.

The substitution proved so satisfactory that as RG&E expanded new Staynew Filters were installed.

Each bank of eight filters is inspected only once a year. Every *other* year, filter elements are dry-cleaned for re-use.

In another filter application, air taken into the utility's four large carbon-ring compressors is filtered in each instance by a Staynew Model DS250 B4 air-intake filter.

A third filter application is the use of a Staynew Model DS350 B5 on each of four other compressors whose output removes soot from boiler walls and keeps slag off arches and passes. On two additional compressors, also used for soot-blowing operations, two larger Staynew filters, Model DS825 B8, are installed.

The final filter application is on a Worthington compressor for house service.

Most of these filters have been installed for years. All of them have a noteworthy record of performance.

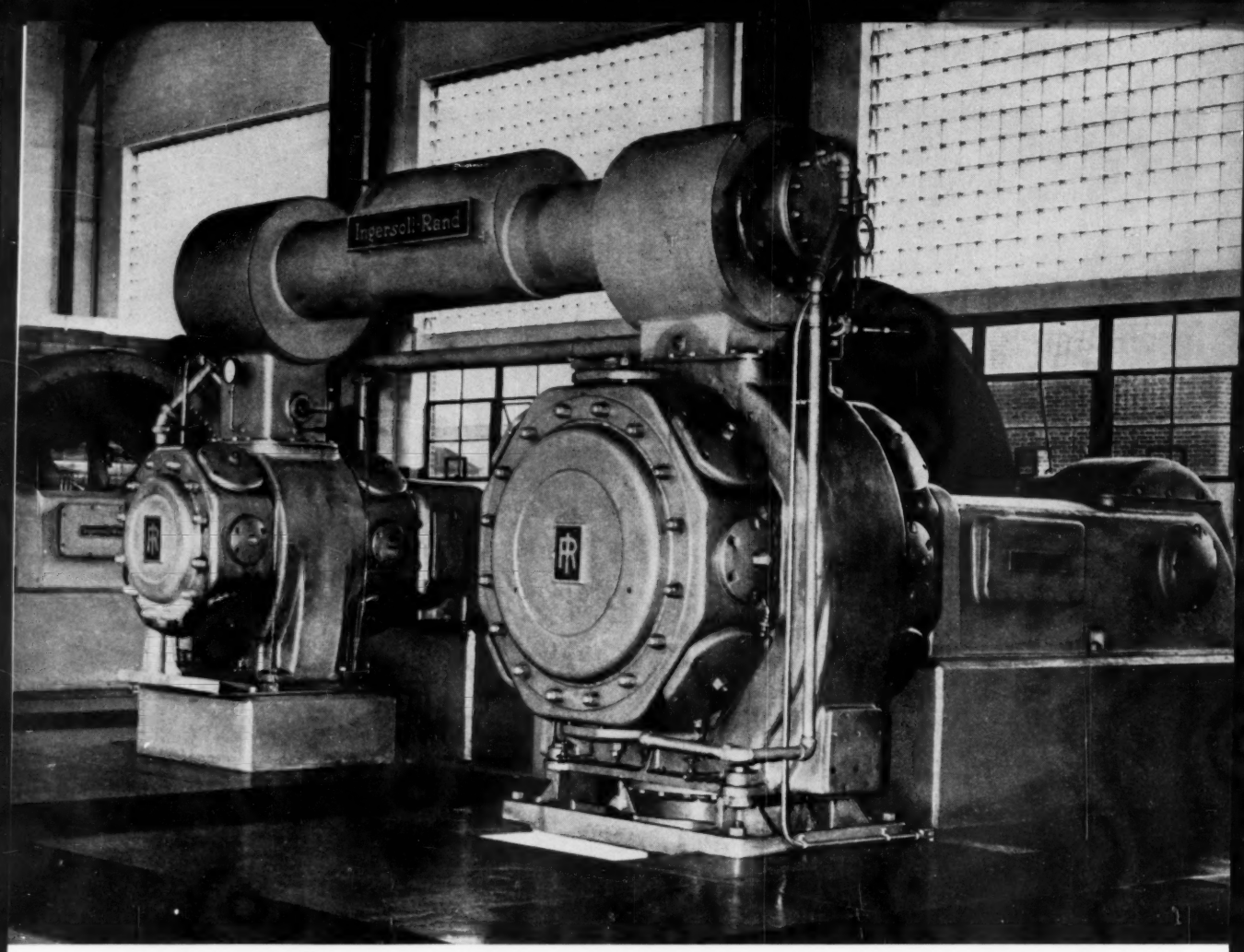
Standardize on Staynew filters, as RG&E has done, for all your filter needs. Write today for Pipe Line Filter Bulletin 200. Dollinger Corporation, 7 Centre Park, Rochester, N. Y.

REG. PROTECTOMOTOR U.S. PAT. OFF.

STAYNEW FILTERS

DOLLINGER

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS



How to stop rust and harmful deposits in air compressors

. . . USE TEXACO REGAL OIL R & O

A sure way to prevent rust and harmful deposits in compressor systems is to lubricate and protect them with Texaco Regal Oil R & O. It is both rust and oxidation inhibited, protects cylinders, valves, etc. against the formation of rust and gum . . . helps keep compressor operation clean and efficient, whatever the working conditions.

There is a complete line of Texaco Regal Oils R & O. A Texaco representative will recommend the right one for your type, size and make compressor and operating condition. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write: The Texas Company, 135 East 42nd Street, New York 17, N. Y.

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

Compressed Air Magazine

Founded 1896

VOLUME 63 NUMBER 9 **September 1958**

PHOTO, ROSA DE LOZ-BIARD

ON THE COVER

SINCE its rapid construction, the American pavilion at the Brussels Universal Exposition, with its 380-foot-diameter bicycle-wheel roof, has become renowned as the world's largest free-span circular building. The roof's 2100 Kalwall plastic panels are hidden by a metal mesh ceiling, as illustrated on the cover. Diffused light from the panels, supplemented by artificial light from above the mesh, plays on it giving a continuous shimmering effect. Additional illumination is provided by a circular curtain wall of clear plastic attached to a self-supporting, gold-colored metal grille—a motif of the architect, Edward D. Stone. William J. Bierach, an American civil engineer, directed a Brussels contractor in the construction.

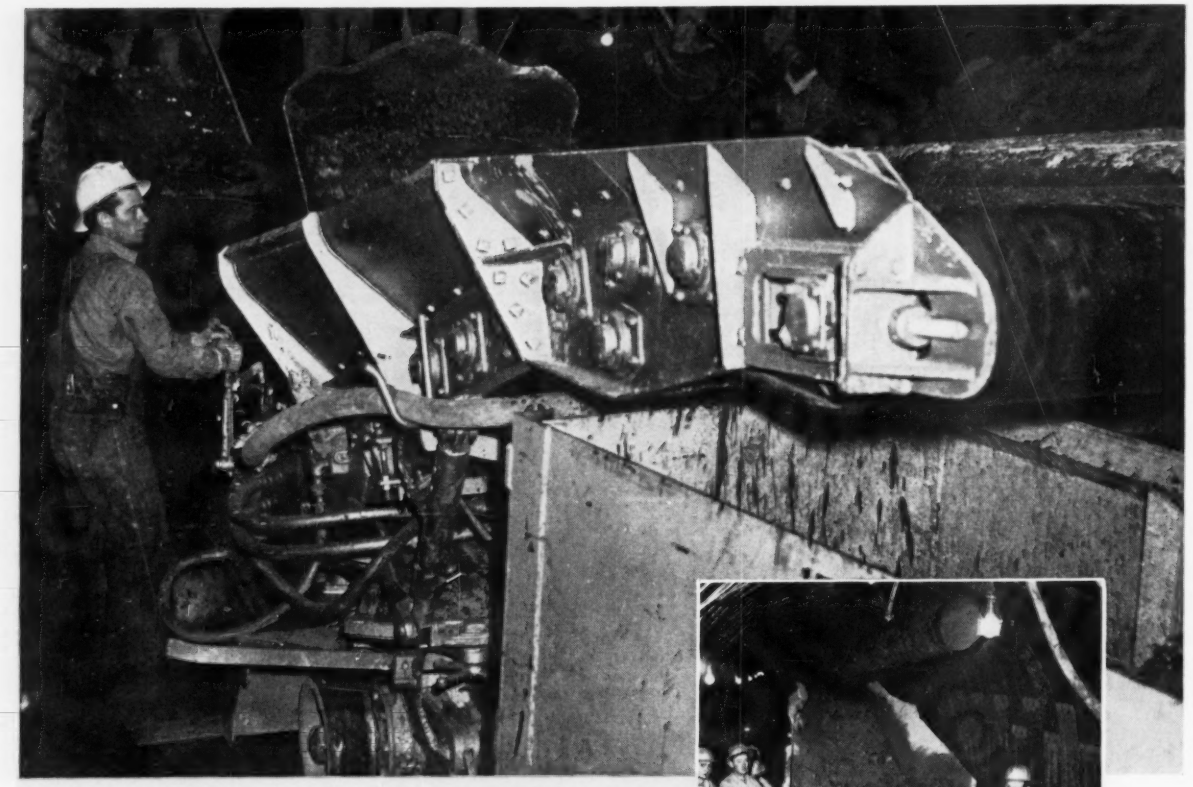
FEATURE ARTICLES

DEPARTMENTS

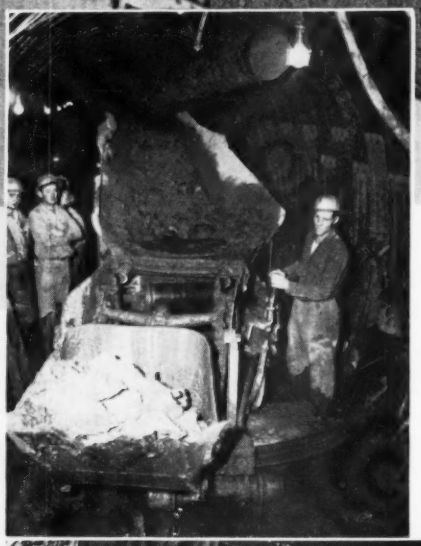
G. W. Morrison, *Publisher*
R. W. Sapora, *Manager*
J. W. Young, *Advertising Director*
J. J. Katarba, *Business Manager*
E. G. Andrews, *Advertising Manager*
H. C. Kinnaman, Jr., *Circulation Manager*
L. H. Geyer, *Representative*,
11 Broadway, New York 4, N. Y.

BPA

EDITORIAL, ADVERTISING AND PUBLICATION OFFICES, 942 MEMORIAL PARKWAY, PHILLIPSBURG, NEW JERSEY. ANNUAL SUBSCRIPTION, UNITED STATES AND POSSESSIONS, $5.00; FOREIGN, $7.00; SINGLE COPIES, DOMESTIC, $0.50; FOREIGN, $0.70. COMPRESSED AIR MAGAZINE IS INDEXED IN INDUSTRIAL ARTS INDEX AND IN ENGINEERING INDEX. MICROFILM VOLUMES (1940 TO DATE) AVAILABLE FROM UNIVERSITY MICROFILMS, INC. PUBLISHED MONTHLY BY COMPRESSED AIR MAGAZINE COMPANY: G. W. MORRISON, PRESIDENT; A. W. LOOMIS, VICE PRESIDENT; J. W. YOUNG, SECRETARY-TREASURER



Eimco Model 40H Loaders are being used in many of the high speed tunnel jobs in work today. These machines are making it possible to average high daily advance footage in all types of ground.



THE DEPENDABLE EIMCO MODEL 40H

Successful contractors, the world over, who make a profit on their job and achieve records in tunnel speed, have learned through experience that you cannot beat the Model 40H for dependable, month in and month out, high performance.

There is now available the Model 40W for headings 14 feet wide — and wider.

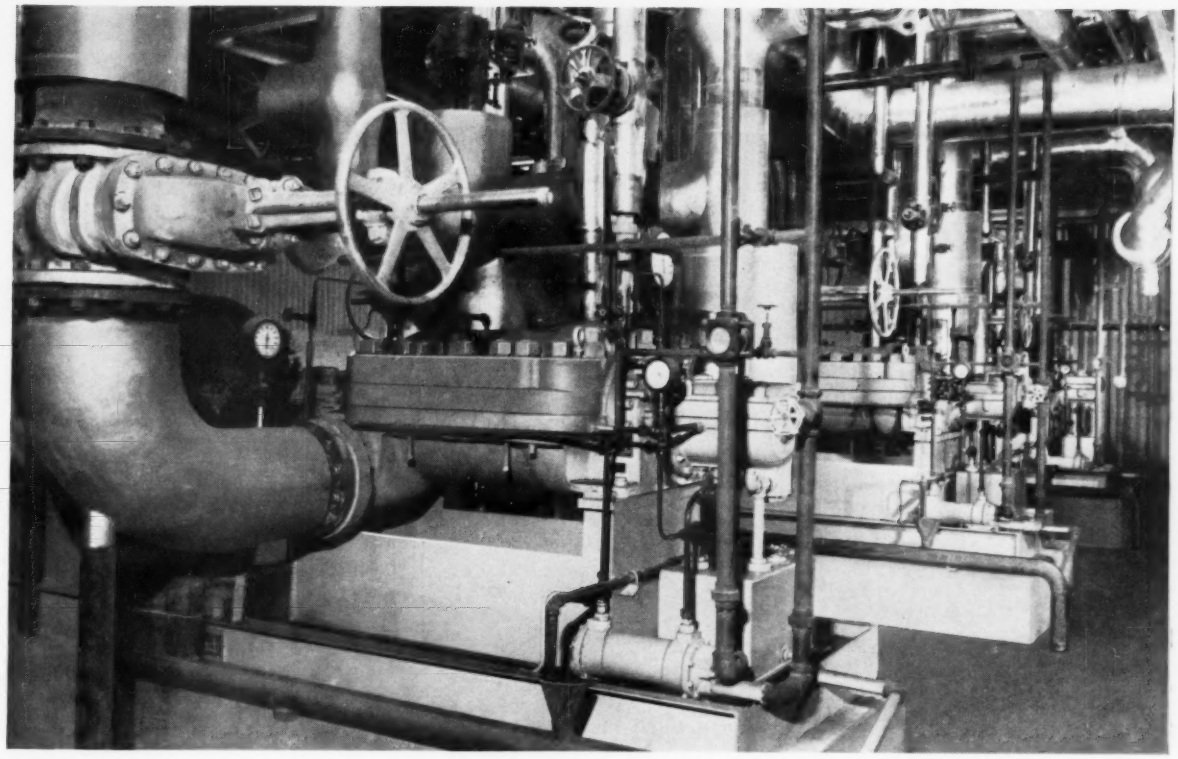
The experienced estimator figures his cost on the basis of using dependable, efficient, low-cost Eimcos.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

New York, N.Y. Cleveland, Ohio · Chicago, Ill. London, England · San Francisco, Calif. Gateshead, England · El Paso, Tex. · Birmingham, Ala. Paris, France · Duluth, Minn. Milan, Italy · Pittsburgh, Pa. · Seattle, Wash. Johannesburg, South Africa

B - 347



ST. REGIS PAPER COMPANY INSTALLS

3 MORE Ingersoll-Rand Boiler-Feed Pumps

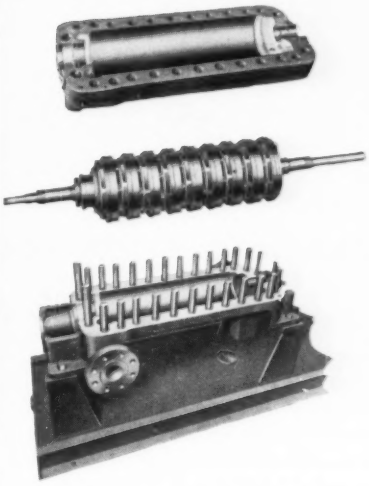
FOR JACKSONVILLE PLANT EXPANSION

WITH the new additions recently completed, the St. Regis Paper Company's Jacksonville, Fla., plant is one of the largest and most up-to-the-minute paper mills in the world.

Typical of the completely modern equipment installed throughout the plant are the three Ingersoll-Rand Class HMTA multi-stage boiler-feed pumps shown above. Each of these 5-stage units handles 1200 gallons of 312°F feedwater per minute at 875-psig discharge. Direct driven by electric motors, these pumps feature Ingersoll-Rand's distinctive Unit-Type Rotor Assembly.

Previously installed at the original Jacksonville plant were three other Class HMTA boiler-feed pumps, each rated 400 gpm, 227°F, 875-psig discharge. The new plant facilities include more than 30 other I-R units – fan pumps, stock pumps, raw water pumps and a variety of other general and special-purpose pumps.

For complete information on any pump for boiler feed and other liquid-moving jobs, just call your Ingersoll-Rand engineer.



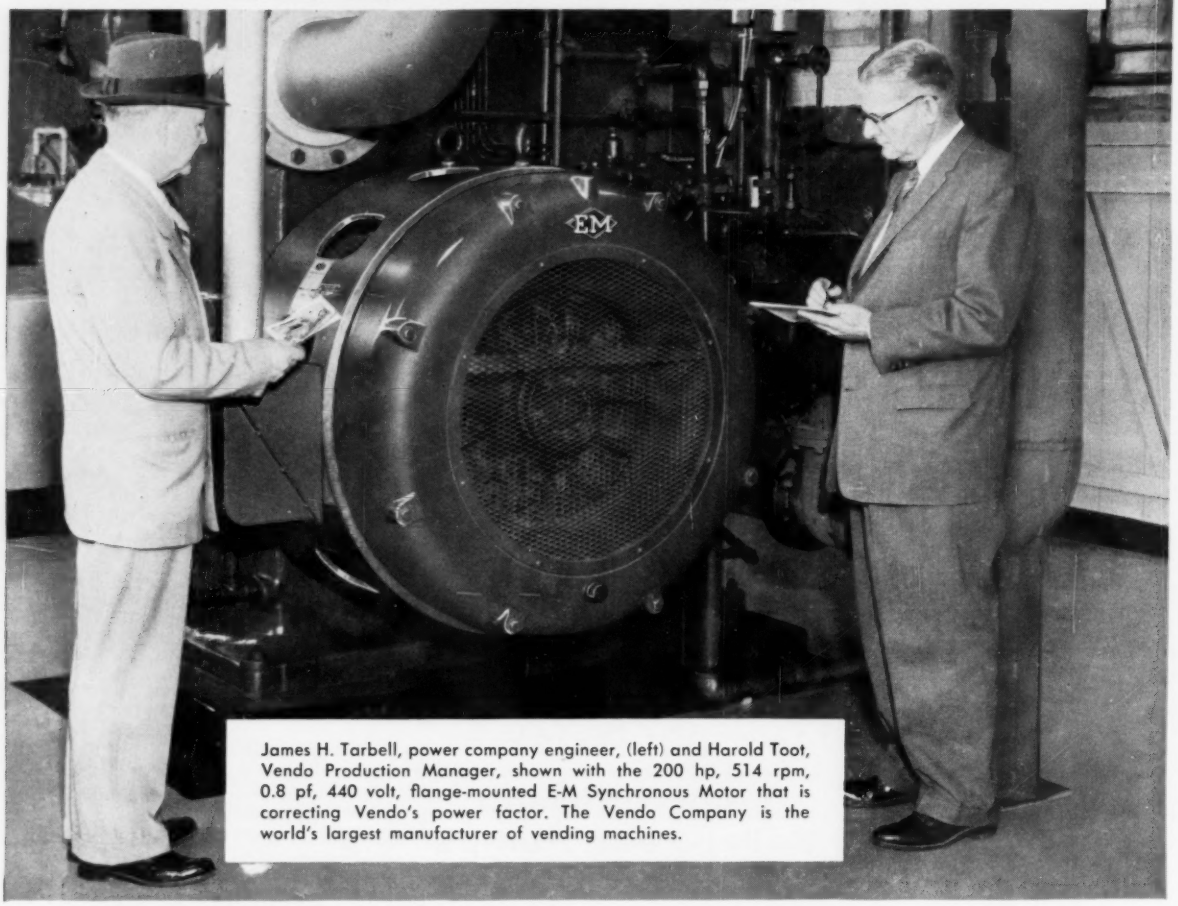
In Ingersoll-Rand Class HMTA pumps, the shaft, impellers and stationary channel rings can be removed and replaced as a single, compact assembly without disturbing suction or discharge connections. Positive interstage sealing and multiple-volute design contribute to higher sustained efficiency, greater dependability and lower maintenance costs.

Ingersoll-Rand

10-862 11 Broadway, New York 4, N. Y.

COMPRESSORS • PUMPS • CONDENSERS
GAS & DIESEL ENGINES • VACUUM EQUIPMENT
AIR & ELECTRIC TOOLS • ROCK DRILLS

Are You Paying Big Penalties for Lagging Power Factor?



James H. Tarbell, power company engineer, (left) and Harold Toot, Vendo Production Manager, shown with the 200 hp, 514 rpm, 0.8 pf, 440 volt, flange-mounted E-M Synchronous Motor that is correcting Vendo's power factor. The Vendo Company is the world's largest manufacturer of vending machines.

Vendo Company Corrects Power Factor...SAVES $450 A YEAR! with an E-M Synchronous Motor

The Vendo Company, Kansas City, Missouri learned its plant was operating at a lagging power factor condition when expanded production facilities required more compressed air. A study by Vendo's engineers and Kansas City Power & Light Company showed an 0.8 leading power factor synchronous motor compressor drive would save them money. Here's how:

Vendo's power contract provides a penalty of 20 cents a month for every reactive kva exceeding one-half the maximum kilowatt demand. *This was costing Vendo $33.00 per month, or $396.00 a year!*

A 20 cents a month bonus is granted for every kilovar the reactive demand falls short of one-half the maximum kilowatt consumption. A 200 hp E-M Synchronous Motor with 0.8 pf would provide enough reactive kva for Vendo to operate at a *leading* power factor and earn a monthly credit of $4.60. Vendo's power bill would then be reduced by $37.60 a month, or $451.20 a year!

Vendo installed the recommended E-M Synchronous Motor . . . and has been enjoying a reduced power bill ever since. You, too, can make a big saving in your plant power bill by correcting your power factor with highly efficient E-M Synchronous Motors.

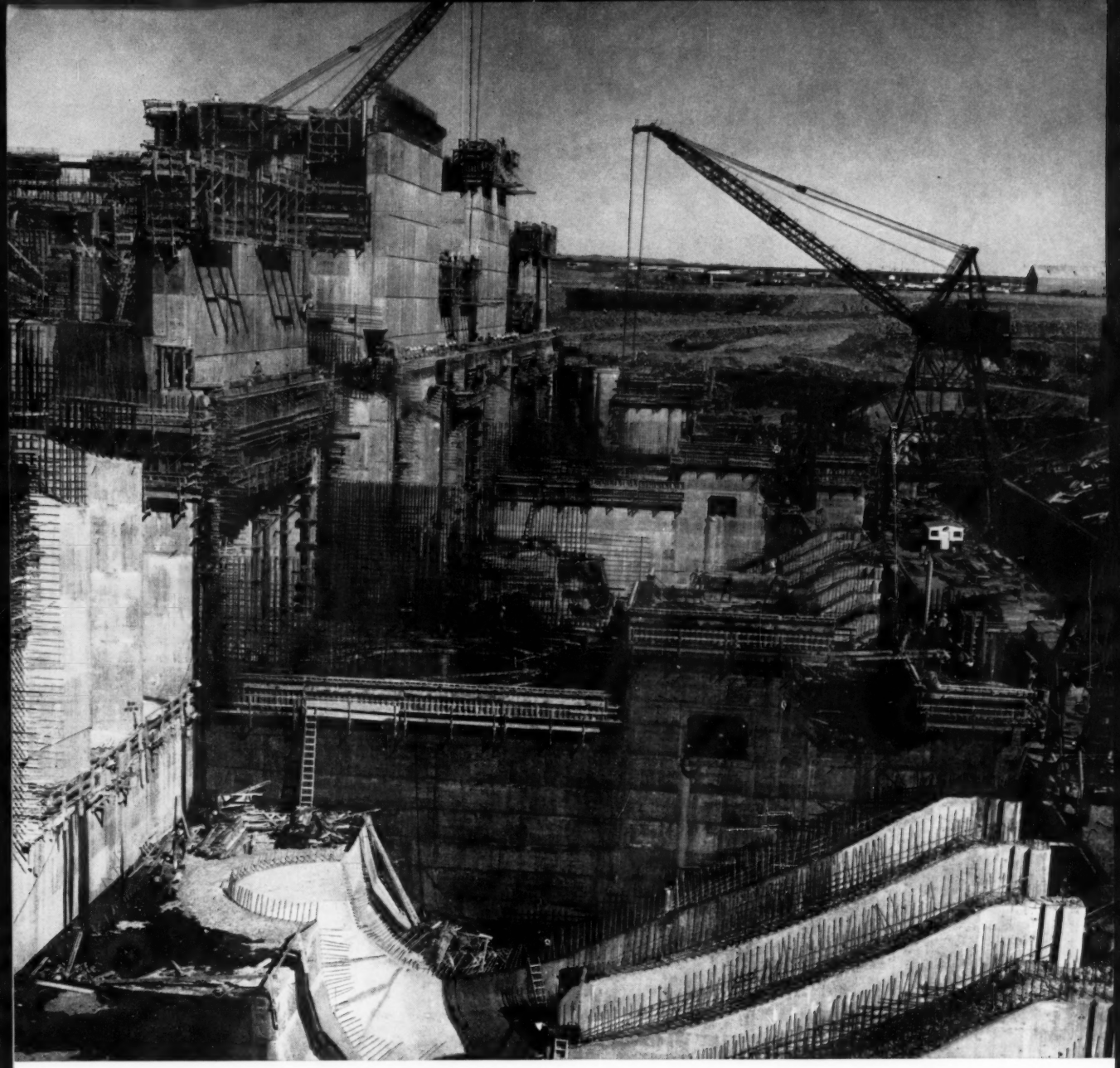
Learn more about Power Factor. Call your nearby E-M Sales Engineer and write for your free copy of the new E-M 24-page brochure, *The ABC of Power Factor.*

E-M

1100-TPA-2187

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO



Forging Ahead at Priest Rapids. This photograph shows construction work on the 1025-ft powerhouse at Priest Rapids Dam, a four-year building project that started in July, '56. Tremendous progress has already been made. Both the Public Utility District of Grant County, Wash., and the Northwest Power Pool can soon look forward to vast new supplies of electric power. Ten generators with a total rating of 788,500 kw will be installed in the powerhouse.

Enormous loads of materials are handled each day as construction proceeds. Cranes and other equipment require great quantities of wire rope, and Bethlehem is furnishing virtually all of it. The rope is supplied in the Purple Strand (improved plow) grade, which has the toughness and strength for any demands imposed upon it.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mill depots and distributors from coast to coast stock Bethlehem rope for the following industries and numerous others:

CONSTRUCTION • EXCAVATING • MINING • QUARRYING • PETROLEUM • LOGGING • MANUFACTURING

NEW Nickel-Plated Brass *Fulflo Filter* for Compressed Air

This new compressed air Fulflo Filter (B-R) is made of gleaming nickel-plated brass . . . sanitary and non-rusting. 7-inch Honeycomb Filter Tubes minimize gumming — remove moisture, oil, microscopic dust, rust, dirt, and scale. Flow rate is as high as 76 cfm of free air at operating pressure of 100 psi. $\frac{3}{8}$ or $\frac{3}{4}$ inch N.P.T.

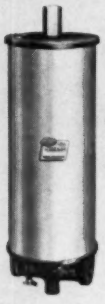
For a new catalog on Fulflo Filters for compressed air, CO_2 and other gases, write to Department CA.

Single Tube Fulflo Filters

B-A model has 3, 5 or 7-inch Honeycomb Filter Tubes for 10, 30 and 60 cfm at operating pressures up to 125 psi. AF model has flow rate of 60 cfm at operating pressures up to 250 psi. ¾ inch NPT.

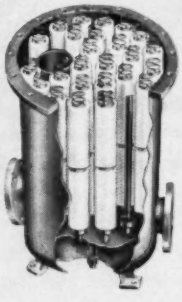
Hi-Pressure Fulflo Filter

Tested at hydrostatic pressure of 8,000 psi, this filter withstands operating pressure up to 4,000 psi. 7-inch Honeycomb Filter Tubes for 1.5 cfm at 4,000 psi (equivalent of 410 cfm of free air).



Multi-Tube Fulflo Filter

For high flow rates or central installations. Three, six, twelve, or eighteen Honeycomb Filter Tubes in parallel. Steel-and-iron, stainless steel, or nickel-plated brass containers. For 1½ and 2-inch pipes. Operating pressure up to 100 psi.



Hi-Capacity Fulflo Filters

This rugged filter is made in 10 sizes — from 22 to 270 10-inch Honeycomb Filter Tubes in parallel. Sturdy welded steel construction — 304 or 316 stainless steel to order. For 3, 4, and 6-inch pipes. 100 psi operating pressure.

COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST

Fulflo FILTERS — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC FILTERS — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*

MORE BUCYRUS-ERIE SHOVELS WORK IN ROCK THAN ANY OTHER MAKE!

. . . your proof of performance from owners!

Bucyrus-Erie grew up in rock, on the Panama Canal, on the Mesabi Range, and on scores of major construction projects which have changed the shape of the earth. Throughout this history, Bucyrus-Erie has continually met the demands of bigger and tougher jobs!

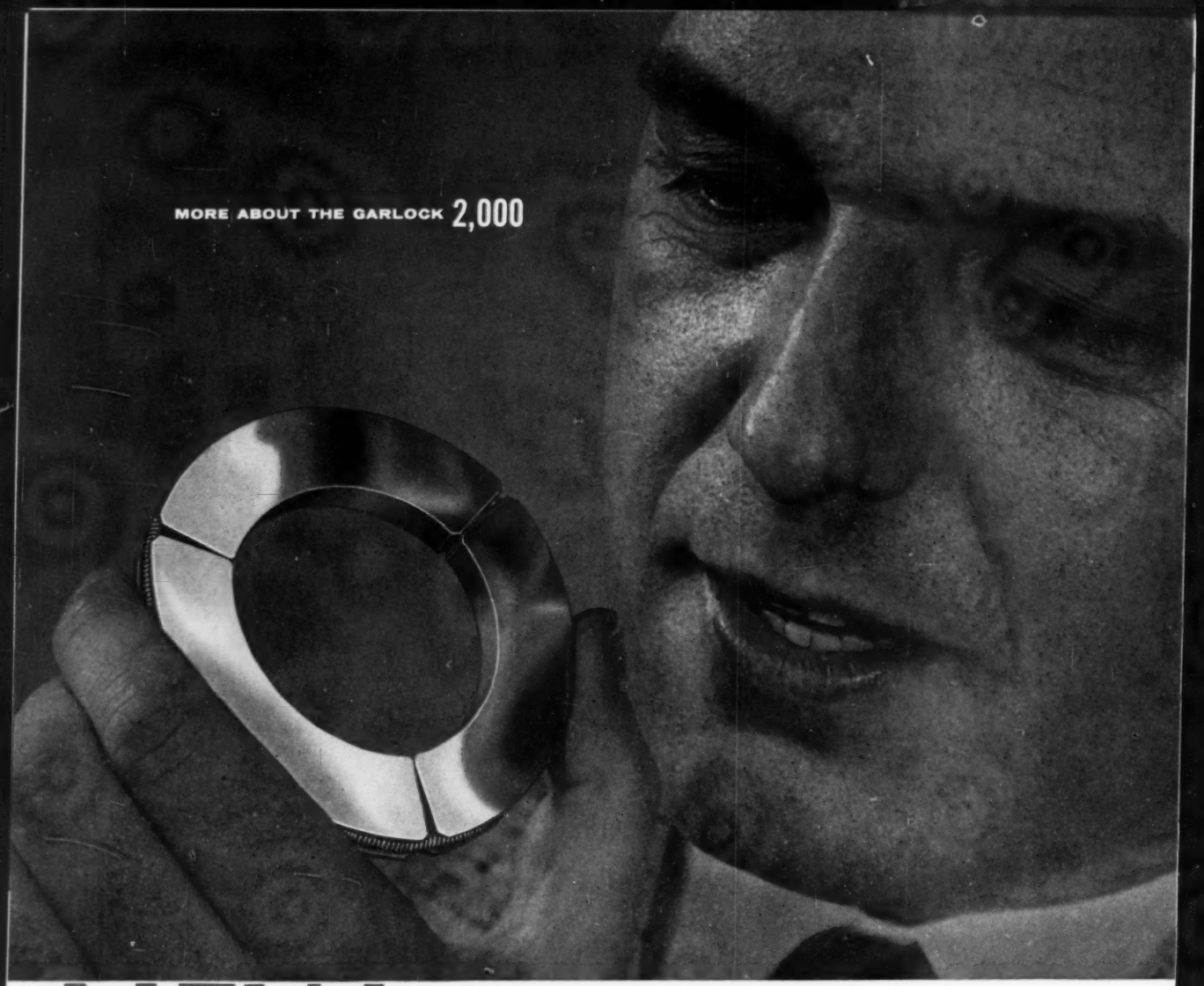
Today's Bucyrus-Erie heavy-duty shovels offer modern front-end design to give you plenty of strength, reduce deadweight, let you move big yardages with minimum effort. Bucyrus-Erie improved Ward Leonard electric control gives you fast acceleration and deceleration with extra torque when it's needed.

Every Bucyrus-Erie is designed with a thorough knowledge of the jobs you have to do and conditions you face!

Write today for complete information about the Bucyrus-Erie excavator you'll need for the big jobs you're bidding right now. There's one to handle your job whatever the size. 183L58C

A Familiar Sign . . . BUCYRUS ERIE *. . at Scenes of Progress*

BUCYRUS-ERIE COMPANY • SOUTH MILWAUKEE, WISCONSIN



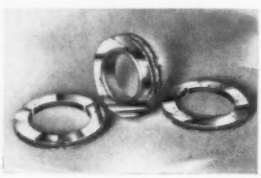
NEW "MIRROR-FINISH" ON GARLOCK METAL PACKINGS

...provides positive sealing at no extra cost

Now all Garlock Metal Scraper and Packing Rings have a surface finish of 10 micro-inches or less! And flatness of the rings is measurable in light bands; which means a more positive seal between ring and groove. This exclusive Garlock advantage has been made possible through improved manufacturing technique and is offered to you without additional cost.

Garlock Metal Packings with the exclusive "Mirror-Finish" are another part of the famous "Garlock 2,000" . . . two thousand styles of packings, gaskets, and seals for every need. The only complete line. That's why you get unbiased recommendations from your Garlock representative. Call him or write for Metal Packings Folder 3888-9.

Floating Metal Packing Sets are designed for use on reciprocating rods of air and gas compressors; steam and gas engines. Available in either solid cup or split-case design. Solid cup design (illustrated at right) withstands pressures to 30,000 psi.



Garlock Metal Packing Rings of graphitic cast iron, bronze, carbon, bakelite and babbit are precision made to exact specifications of size and finish assuring maximum efficiency.

THE GARLOCK PACKING COMPANY, Palmyra, New York

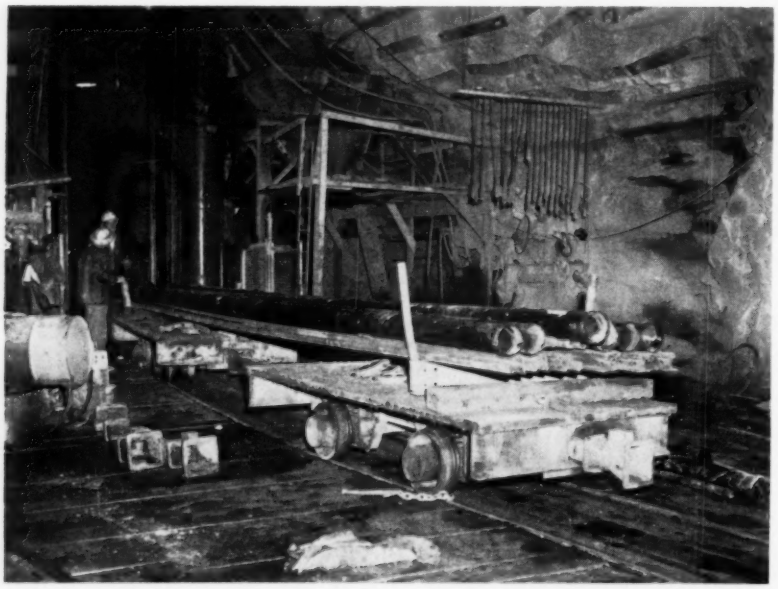
For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

ABOVE AND BELOW

The headframe of Shaft 4 (Contract 453) is shown above. At the left, a concrete truck is delivering its load to a hopper from which it is sent below. When this picture was taken, concreting was proceeding only along the curb lines, pending completion of drilling and blasting. At the right, a Euclid truck is taking on a load of muck from the headframe hopper. Spoil was taken to the surface by a 15-yard skip. At the far right can be seen the snubbers for the two 200-hp rotary blowers that furnish ventilation to the workings. Below is shown the foot of the 14-foot-finished-diameter access shaft. A load of pipe and track was being brought to the headings when the picture was taken. The track on which the cars are shown bypasses the actual shaft which is just to the left. A similar bypass on the left side of the bell-out section was used for dumping loaded muck cars into a skip hopper below grade. Thence it moved into the skip.



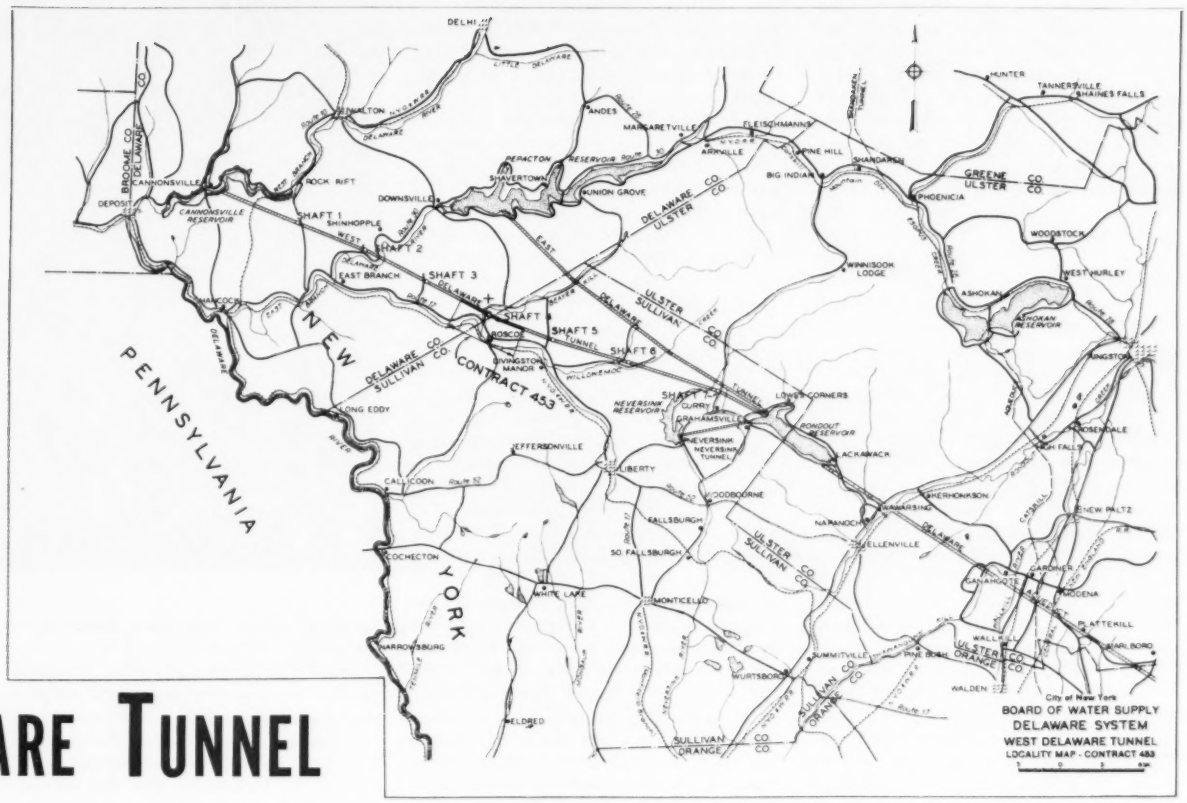
R. J. Nemmers

Large-Diameter, Burn-Cut Drilling Speeds Work On—

West Del

CURRENT work on the West Delaware Tunnel of the Board of Water Supply of the City of New York provides an interesting comparison between the relative effectiveness of angle-type drill patterns and the so-called burn-cuts. On the East Delaware Tunnel, a 24.7-mile bore having approximately the same excavated diameter of 14 feet as the West Delaware Tunnel, the angle cut was used exclusively and resulted in an average advance of 8.3 feet per round according to unofficial Board of Water Supply figures. Burn-cut drilling on the West Delaware Tunnel has resulted in an average advance of from 9 to 10 and more feet per round with a maximum of more than 11 feet per round in one heading in which a special jumbo, mounting a heavy drill for punching out 8-inch holes, was used.

The so-called Vee, pyramid or wedge cuts are most effective when the angle between the drill holes and the longitudinal axis of the tunnel is about 45 degrees. Designed to blow out a cone-shaped portion of the rock face, so that the remainder of the rock to be blasted in the round can be broken into the resultant cavity, angle cuts are limited in depth by the excavated width of the tunnel. There must be room to operate drills, change steels, etc., thus making it impracticable to drill 45-degree holes within the limited confines of most bores. Consequently, angle cuts are, in all but the largest of



VARE TUNNEL

tunnels, compromises between a reasonable advance per round and the most efficient use of time and explosives.

Burn-cuts, on the other hand, utilize an empty or unloaded hole or holes to provide room for additional rock to break out. With the burn cut, then, the depth of the round is not dependent on the working space available for drilling holes at an angle. Joseph Yancik, Jr., and George B. Clark, of the University of Missouri School of Mines & Metallurgy, performed a series of experiments on burn-cut drill patterns resulting in a fund of empirical data indicating, among other things, that the depth of the round is limited primarily by the volume of the break-out space in the burn-cut hole or holes. (A number of patterns were tried, with the burn-cut holes ranging in diameter from 5½ to 13 inches, the majority being of 9-inch diameter.)

When completed, the West Delaware Tunnel will be a 44-mile-long, 11-foot 4-inch-diameter, concrete-lined bore designed to feed water from the Cannonsville Reservoir (now under construction) to Rondout Reservoir and thence, through the Delaware Aqueduct, to the city. It is a portion of the third stage of the Board of Water Supply's plan to meet the needs of the great city for some years to come. The Cannonsville Reservoir, impounding the flow of the West Branch of the Delaware River, will have a safe daily yield of about 310 million gallons. The Cannonsville Dam is to be an earth embankment, approximately 175 feet above the bed of the river. It will entrap some 97 billion gallons of water (at surface elevation 1150) from a 450-square-mile watershed.

The tunnel work was divided into five contracts numbered from 451 through 455, proceeding in order from the west (Cannonsville) end, to the east (Rondout) end. No. 451 was let to a joint-venture firm consisting of Johnson, Drake & Piper, Inc.; Grafe Callahan Construction Company; Tecon Corporation; Winston Brothers Company; and the Conduit & Foundation Corporation at a bid price of $15,367,492.80. Contract 452, awarded to the same combine, totaled $20,352,096. Contract 453 went to MacLean•Grove Brewster, a combine consisting of MacLean•Grove & Company, Inc. and Geo. M. Brewster & Son, Inc., on a low bid of $11,771,580. A joint venture consisting of the same firms engaged in work on Nos. 451-2, with the exception of Grafe Callahan & Company, won contracts 454-5. Total bid for the two was $43,904,554. (The accompanying map shows the location of the tunnel and of Contract 453.) Contracts were let and work began generally in the numerical order of the jobs.

When work began on Contract 451, the contractor elected to try the burn-cut method. Four 3-inch holes, aligned vertically just below the centerline of the bore, were utilized. Progress averaged approximately 9.3 feet per round at the inlet and 10 to 10.1 feet in the headings at Shaft 1. A jumbo, from which two 5-inch diameter holes could be drilled for the burn cut, was utilized on Contract 452. Rounds in Shaft 2 headings averaged 10.1 to 10.4 feet per round; and, in Shaft 3, 10.7 to 10.8 feet.

An integrated drilling machine was brought into play on each of the Shaft 4 headings (M•G B's Contract 453) utilizing a "down-the-hole" drill and an 8-inch bit to drill one burn-cut hole per round. These rigs have scored the greatest average advance per round to date—more than 11 feet. It is apparent that with the ability to attain a greater advance per round that a considerable increase in daily progress can quite readily be attained as compared with the use of the standard Vee, pyramid or wedge cuts.

The drill rigs are as different from early jumbos as Simon Ingersoll's first compressed-air drill was from previous hand methods. Essentially the jumbos are tunnel-driving machines, being integrated units rather than just rock drills on a movable mount.

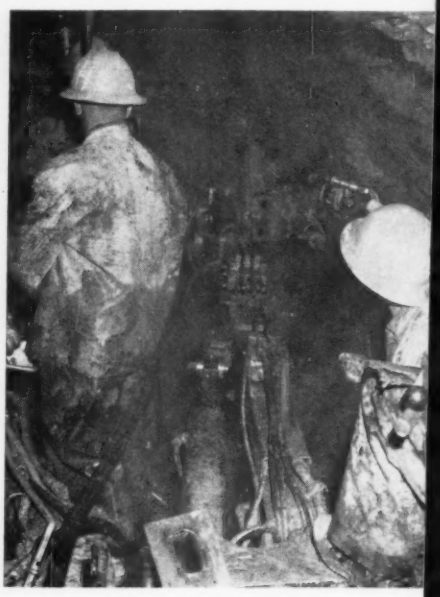
Each of the Ingersoll-Rand designed-and-built 2-deck units carried six I-R DB-35 drifters mounted on PF4 aluminum power feed shells of 6-foot length. Three of these were mounted on 8-foot-long HBCT foot-mounted Hydra-Booms

with power dump, swing and cone. These three machines were on the upper deck of the drill rig. Two more of the drifters were on similar face-mounted Hydra-Booms, and the sixth one, the center drill on the lower deck, was mounted on a CM2 5½-foot Hydra-Boom, also having power swing, dump and cone. Three hydraulic pumps, interconnected so that one pump could serve the entire rig if required, supplied hydraulic power not only for the Hydra-Booms, but for the wings and a hydraulic "stinger" on the front of the rig. Normally, one pump operated the top-deck booms and another the lower-deck, the third being reserved to operate wing cylinders and the stinger. Each of the 2½-gpm, 1500-psig pressure Vickers pumps was powered by an I-R 9MJ Multi-Vane pneumatic motor. All hydraulic controls for the Hydra-Booms were mounted on the booms, with the exception of the center machine on the lower deck. Remote controls for this inaccessible rig were located on the right-hand side of the jumbo. Lubricant for the drifters was furnished from a central oil reservoir mounted in the frame.

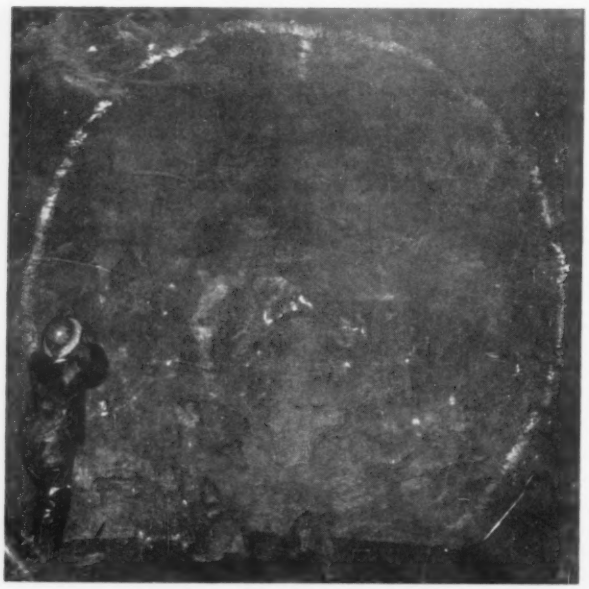
The 8-inch burn-cut drills were the DHD 400's which more often are found drilling vertical holes from the firm's Quarrymaster self-contained drill rig. The ones used with these jumbos for horizontal drilling were modified for wet drilling by use of a special water-injection swivel on the drill rod and special internal members. The percussion machine was rotated by a DRD2 rotary head which is essentially the same machine found on the Quarrymaster, except that it was slightly modified for horizontal operation. The drill was advanced into the hole by a standard DFM feed-motor by means of a 2-inch-pitch roller chain, spring-loaded to absorb shocks.

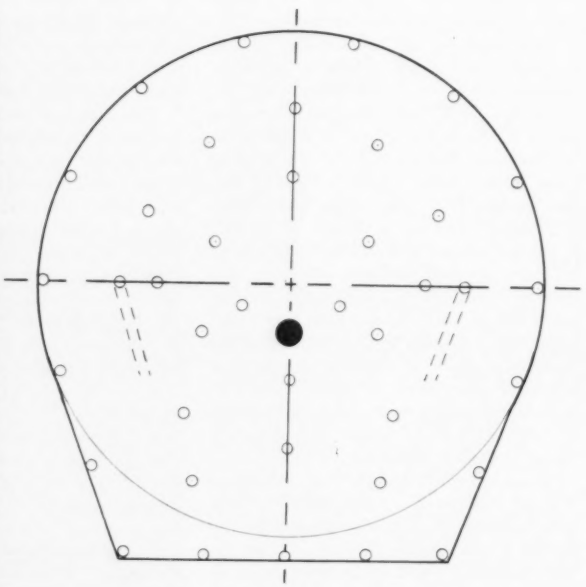
A remote-control panel incorporating all controls for the large-hole drill was located on the left-hand side of the jumbo. Included in the control station was a pilot water-operated air valve complying with New York State regulations specifying that means must be provided to assure that water is turned on before a drill can be started.

In addition, the drill rig was equipped with a sludge-collector system for the burn-cut drill. This consisted primarily of an I-R 5G125 vertical type "G" blower mounted on the rear of the jumbo. Driven by an I-R 5QDC air motor, the blower capacity was 2000 cfm at approximately 0.25-psig pressure. Taking suction from a sludge drum, which in turn was piped to a dust hood and collar fitting around the drill steel at the tunnel face, the blower then exhausted, through flexible tubing, to the tunnel exhaust system. The sludge box, basically, was a large baffled container in which air velocity was reduced and its direction of flow altered abruptly many times to allow large dust particles to settle out.



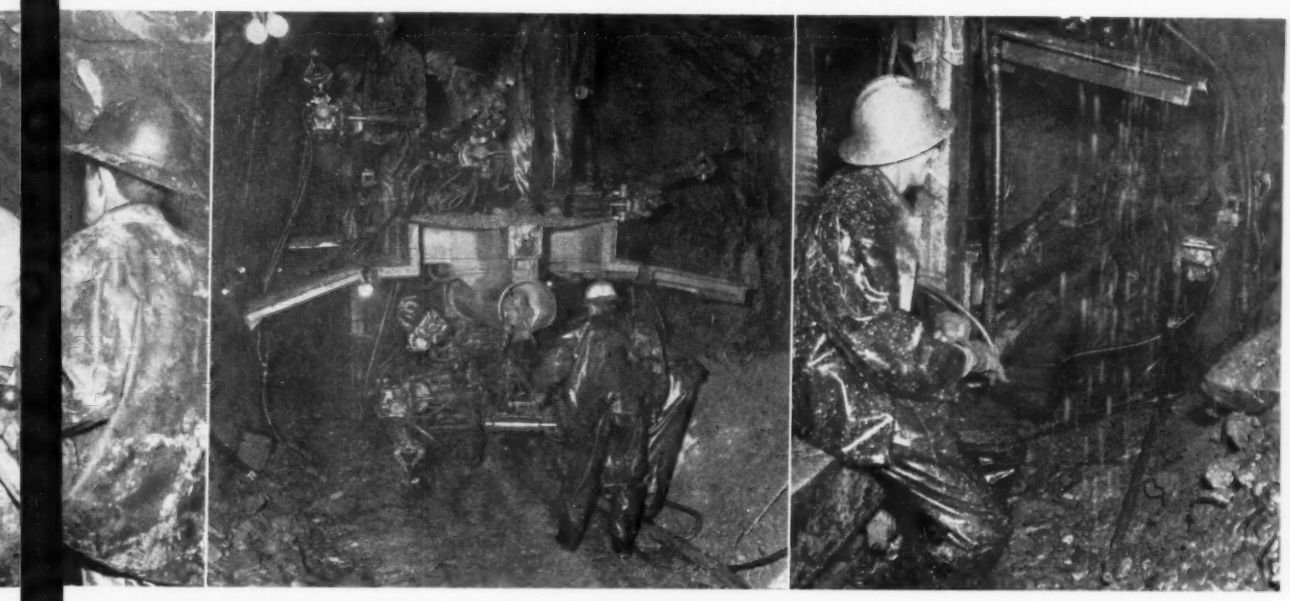
Besides the drills and sludge collection system, the rigs were fitted with air preheaters having a dual effect on work in the tunnel. They boosted the air pressure by returning thermal energy to it, and, as a direct result, reduced the fogging usually encountered.





8-INCH BURN-CUT PATTERN

The West Delaware Tunnel is being excavated to a diameter of about 14 feet. Shown in the sketch is the approximate drill pattern used on Contract 453. Shot holes, except as indicated, were put in parallel with the tunnel axis. The 8-inch unloaded burn-cut hole was placed just below the center line. All holes were 12 feet in depth. In one heading, this pattern resulted in an average advance of more than 11 feet per round—approximately 80 percent of the tunnel diameter. In contrast, progress on the similarly sized East Delaware Tunnel, in which only angle-type cuts were used, averaged but 8.3 feet per round—60 percent of the tunnel diameter. The picture shows the heading marked for drilling another round. To do this, the center line of the bore was determined with the aid of a transit and plumb lines, and then the white ring was scribed with whitewash.

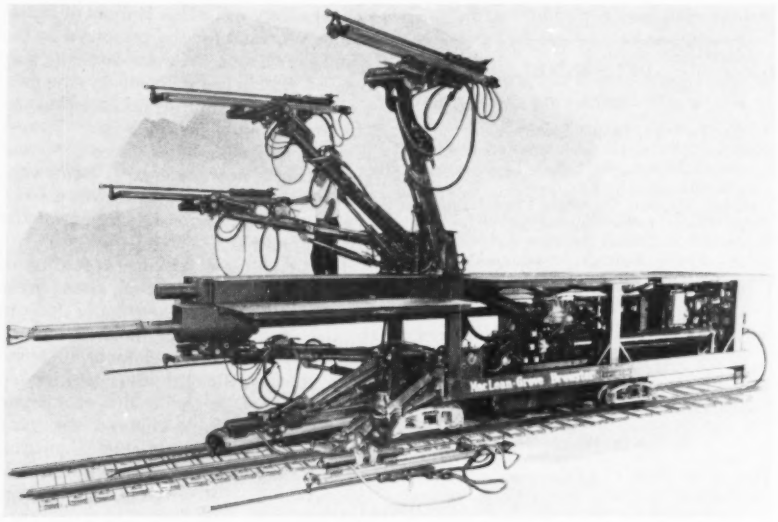


JUMBO DRILLING SCENES

In the center is shown a head-on view of the jumbo as it was being readied for another round. The 8-inch bit of the DHD 400 drill is visible in the center of the rig with the dust-collector hood surrounding it. Six Ingersoll-Rand DB35 drifters completed the drilling equipment, three on the top deck and three below. At the left is a view from the top deck as the initial holes in the round were being put down. The hydraulic controls for the Hydra-Boom are visible just left of the backhead of the drill. In the third illustration, the lower right hand drill on the jumbo is shown in use. The water shower visible as white streaks is from a stoper operating overhead.

The preheater section first heated water, then transferred the heat to incoming air. There were three electrically energized Chromalox water circulation heaters, each of 30 kw at 440 v (3-phase). The unit was designed to heat air from an incoming temperature of 60°F to a maximum of 180°F. Water was circulated by an I-R 1½ KRVS ½-hp pump through an I-R pipeline-type heat exchanger. The heaters and their thermostat controllers were placed in a rubber-mounted enclosed box to isolate the equipment from drill vibrations.

Structurally, the rigs were built up of welded structural steel. The main longitudinal and vertical members were box sections made of two channels welded continuously toe to toe, thus forming a stiff simple frame. Those box sections were utilized as integral flow passages for the sludge collector system, thus minimizing the use of large-diameter hoses that might interfere with efficient work on and around the drills. The top deck, from which stopers were operated for roof bolting work, was covered with safety plate steel, an access ladder being positioned on the rear of each jumbo.



JUMBO PROFILE

This profile view of the jumbo, taken before the rig was sent underground, gives a more accurate idea of its design than can pictures taken in the cramped quarters in the heading. M•G B also utilized a service trailer behind the jumbo to carry drill steel, roof bolts and lubes.

The electrical system powering the drill rig receives its energy from a 440-v line carried to the tunnel heading. "Square D" electrical controls of watertight construction were used throughout the rigs. The water circulating pumps were driven by totally enclosed fan-cooled motors. Control current was primarily 115 v and other equipment operated at 440 v.

One 6-inch air line extends the length of the tunnel. Air is supplied by a compressor plant of 950-hp total capacity composed of two 250-hp and three 150-hp reciprocating stationary compressors. Two 200-hp rotary-type blowers pump air from the heading to the surface through 26-inch Naylor pipe. A 2-inch water line and a 6-inch pumpage line complete the battery of cables and pipes that followed the headings.

A 36-inch-gauge track system is installed through the length of the tunnel. Operating on it at present are Plymouth diesel locomotives of 10- and 12-ton capacity and the concreting equipment. When drilling was in progress, Watt side-

ROOF BOLTING

Six-foot-long Bethlehem roof bolts were installed from the top deck of the jumbo during drilling operations using Ingersoll-Rand RP38 stopers. Three steel changes were needed, the holes being collared at 1⅝ inches and bottomed at 1½ inches. The stopers were also used to drill any rock projections into the tunnel, which were then loaded and fired with the regular rounds.

dump muck cars, Conway muckers and the drill jumbos all operated on the system. A series of bypass switches and a miniature switching yard at the foot of the shaft complete the trackway.

Contract 453 was awarded October 9, 1956, and notice to begin work on the estimated 60-month job was given 8 days later. Work actually began November 12 with ground clearing and service-structure erection. The 14-foot (finished diameter) shaft was collared the following February 5, and the first concrete placed in the access opening a month later. A burn-cut pattern was also used in shaft sinking on Contract 453. Preceding the actual collaring of the hole, the contractor drilled a 12-inch-diameter hole in the center of the shaft which was then used as the burn hole during excavation. To keep the hole from filling with muck, it was backfilled with a soft cement-bentonite-sand compound.

The shaft reached the "bell-out" section and was largely completed in May 1957. Limited crews immediately began driving tunnel while the remainder of shaft work was completed. On August 22, the temporary headframe was dismantled, and the permanent one went into operation about a month later. Three shifts began working in the headings on September 17. As crews gained experience in working with the big rigs, the daily advance pushed upward to six rounds, and, in the east heading, an average pull per round of 11.2 feet.

Two steel changes were used on the drifters, a 1⅞-inch tungsten-carbide-insert bit on the starter 6-foot length and a 1¾-inch bit on the finish steel. Twelve-foot holes were drilled by all machines, including the big drills which used 8-inch Carset (tungsten-carbide-insert) bits. Holes were loaded using standard delay caps in periods from 0 to 8 and Atlas Geladyne 2X powder. After blasting and mucking and during drilling for the next round, 6-foot-long Bethlehem roof bolts were installed as required using two Ingersoll-Rand RP38 stopers operating from the upper deck of the jumbo. These holes were started with 1⅝-inch bits and bottomed at 1½ inches using three 2-foot steel changes. Although one of the advantages of burn-cut tunneling, according to engineers on the job, is that overbreak is closely controlled, the use of roof bolts close to the heading and arranged along the arch prevented vaulting of the roof with each subsequent blast. Any rock projections into the tunnel were drilled and fired with regular rounds.

As we have indicated, mucking was accomplished with a Conway 75 electrically powered unit discharging to Watt cars. A car siding was maintained within easy reach of the heading. The side-dump muck cars were dumped into a 15-yard skip from a skip pit at the base of the shaft. Two cars made a skip load, which was then hauled to the surface and discharged into a hopper from which the muck was loaded into dump trucks for haulage to the spoil disposal area.

The approximately 26,000-foot-long Contract 453 lies about 380 feet below the surface (at the shaft) in a hard, Catskill Mountain, gray sandstone and shale of carbonaceous origin. The abrasive nature of the rock is hard on equipment, but the M•G B supervisors are carrying on an excellent preventive maintenance program. Actual driving of the tunnel was carried on 5 days a week, and the maintenance program occupied the sixth working day.

The tunnelers on Contract 453, as well as on the others, have established an excellent safety record. A Bureau of Mines course was held for the personnel at the MacLean•Grove Brewster site, the success of which is indicated by the fact that no serious injuries occurred during the drilling and blasting work. Tunnel driving was completed August 8, and concreting is now underway. Some concreting along the curb lines was accomplished during the actual driving of the tunnel, as well.

Burn-cut tunnel driving, according to most observers on the scene at the West Delaware Tunnel, is the coming thing in tunnel work. Large-diameter-hole burn cuts are also growing in favor. At one time it was thought that placing so much reliance on the ability of a single large-hole drill to withstand the hard usage underground was akin to putting all one's eggs in one basket; if the drill caused excessive down time, tunnel progress would be delayed. The experience of M•G B with their large-hole drills indicates, however, that these machines add a great deal to the actual tunneling rate without presenting undue maintenance problems.

PERSONNEL

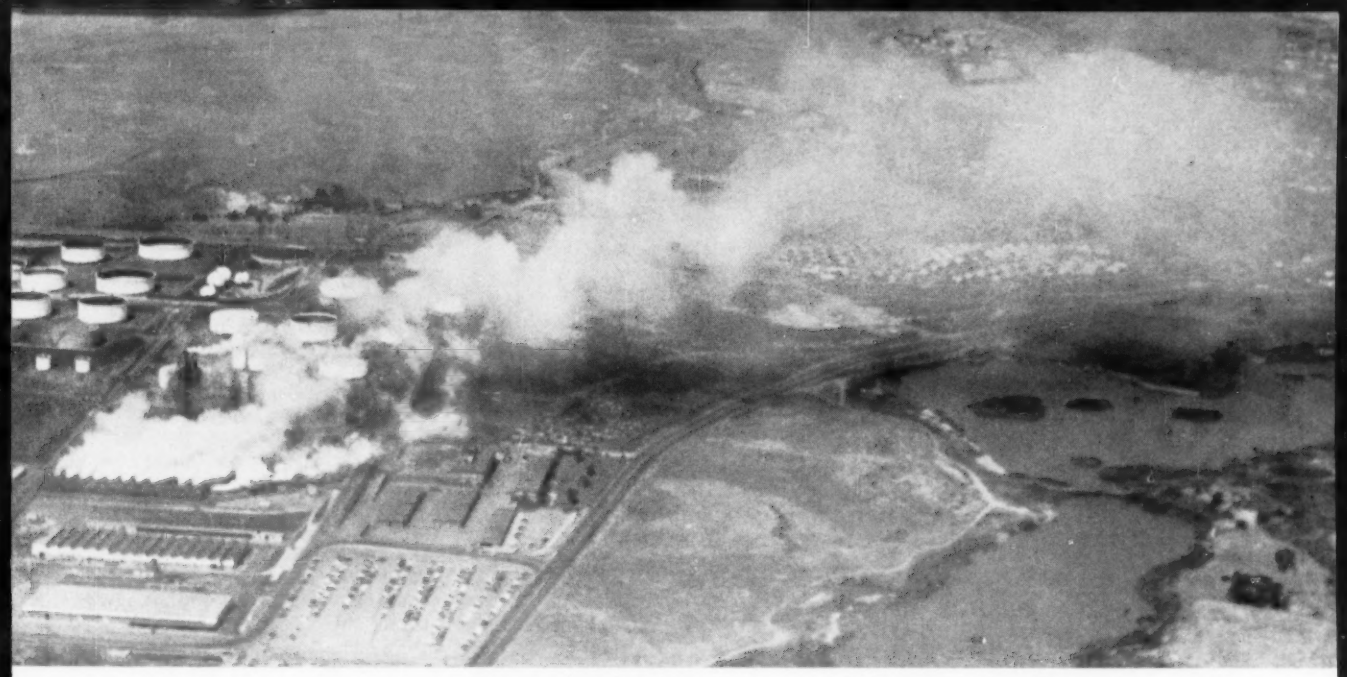
CONTRACTOR

M. L. MacLean, Project Engineer
Eugene C. Tufts, General Superintendent
Clayton C. Kilpatrick, Safety Engineer
Guy Simoni, Project Engineer
Anthony Iacoponi, Assistant Project Engineer
Ovila Bibeau, Office Engineer
Robert Morris, Shaft Engineer
John J. Duffy, Assistant Superintendent
Joseph Romolo; Robert Wiggins; William Orr; Donald Herron; and W. E. Lawrence, Walking Bosses
(10 miners, 6 chuck tenders, 1 nipper per crew per heading)
John Reed, Master Mechanic
C. P. Stanton, Electrical Superintendent
Paul DeMarco, Topside Labor Foreman

BOARD OF WATER SUPPLY

Stanley M. Dore, Chief Engineer
N. Leroy Hammond, Deputy Chief Engineer, Construction Department
Bernard J. Sullivan, Executive Division Engineer
W. Courtland Thomas, Hancock Division Engineer
John G. Mergott, Section Engineer

Ray Johnson, Assistant Section Engineer.



A VANISHING SIGHT

The white cloud coming from a catalytic cracking unit at a Los Angeles refinery is mainly water vapor and carbon monoxide, with small amounts of unburned hydrocarbons and catalyst dust. However, it looks ominous and invites criticism. One refinery has put in a boiler that utilizes the carbon monoxide as fuel and two others are constructing them. Such installations help clean up the atmosphere and also supply a considerable part of the heat needed by the refinery operations.

Smog

Part 2, Petroleum Industry Control Techniques

C. H. Vivian

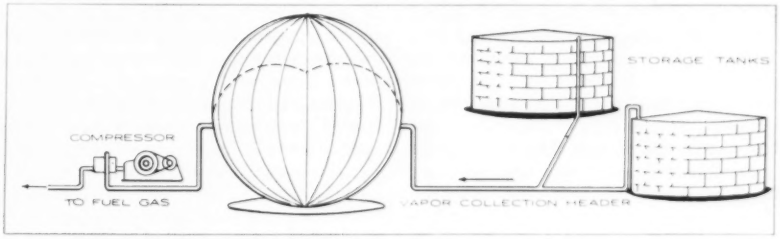
LOS ANGELES is the center of a large petroleum industry. The operations include the production and refining of crude oil and the marketing of the products. More than 300,000 barrels of crude oil, which is 40 percent of California's output, is produced daily from the oil fields of Los Angeles County. It, and a still larger quantity that is brought in by tank ships and pipelines, is processed.

Los Angeles is the third largest petroleum refining center in the country. In 1956, six major oil companies and two large independents processed an average of 670,000 barrels of crude oil daily. Ten smaller local operators put through 64,000 barrels, making a total of more than 730,000 barrels. Gasoline production is approximately 15 million gallons a day, of which nearly two-thirds is shipped outside the area. In addition to the refineries, 24 natural gasoline extraction plants process gas produced with the oil or separately.

At every stage where petroleum and its products are handled, hydrocarbon vapors are formed and will escape unless this is prevented. Thus far, the oil industry has spent more than $30 million to avert it. A great deal of the control effort was initiated before smog became a public issue, because it was good business to do so. Wherever it has been profitable to stop leakage or to recover vapors at points of emission, the oil companies have been quick to act without urging or compulsion from outside sources.

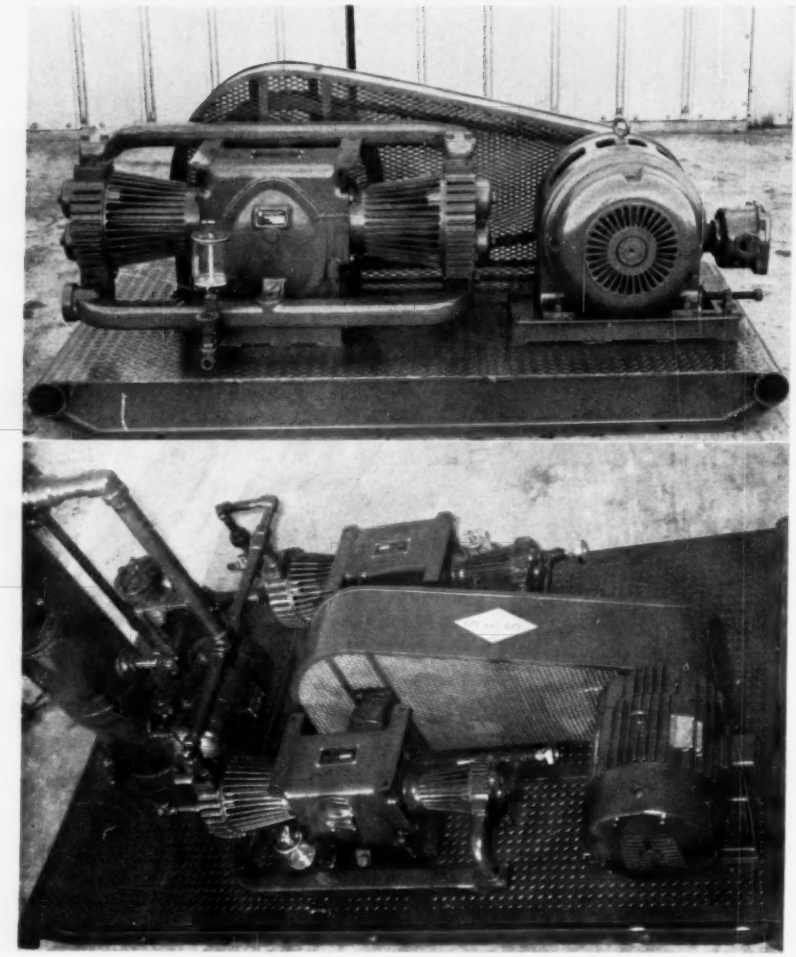
For example, several of them installed control equipment at their refineries prior to 1930, which was long before the County's smog problem reached serious proportions. Since the attack on smog has become an organized public movement, these control systems have been improved and enlarged. To show the public what they are doing to help combat the smog situation, several companies have issued illustrated booklets explaining the various types of equipment used. Shell Oil Company did an outstanding job of this type.

As is natural in such situations, there has been a tendency in Los Angeles to blame "the other fellow" for the smog nuisance. Individuals, although contri-



TANK-VAPOR RECOVERY SYSTEM

The vapor is collected in the sphere, then withdrawn, compressed and directed into a fuel gas system.



WET-GAS FIELD COMPRESSORS

Ingersoll-Rand compressors, mounted, as shown, by Santa Fe Springs Manufacturing Company, of Los Angeles, are used for recovering vapor from oil tanks in producing fields. The compressors are adaptations of the Type-30 line of air-cooled general service machines. Whereas the cylinders are normally close to upright, for this service they are laid down flat, with the discharge valves on the bottoms of the heads. This assures the removal of any condensed liquid, which would otherwise dilute the lubricant and cause serious cylinder and piston ring wear. The portable assemblies do not require concrete foundations or water supply or piping for cooling. The compressors are driven through V-belts. The single model (top) is single stage and discharges at pressures up to 55 psig. The double model (bottom) is two stage and discharges at up to 220 psig. Auxiliary equipment shown on the left is a suction scrubber with high-level shutdown. To conserve floor space and contribute to portability, motors can be mounted on the compressor crankcases in the overhead position, in addition to the base-plate mountings shown.

buting contaminants by driving cars and burning rubbish, would point to smoke and steam rising from stacks and say, "There it is!" Also, it is easier for the authorities to ride herd on a few thousand industrial establishments than on millions of residents. Thus, industry has received first and major attention.

As for the petroleum refiners, they have been quoted as saying in effect: "The smart thing here is to operate a refinery that can't be seen, heard or even smelled." That is their objective. Since 1948, they have curtailed hydrocarbon emissions to about the minimum.

All major refineries assign from two to eight men each to the air-pollution problem, and they report directly to top management. The same men police waste water, also a problem in arid Los Angeles. In addition, all operating personnel devote some time to these matters. Some of the routine duties are to watch all possible sources of hydrocarbon losses, which include checking all pumps and valves for leakage and periodically determining the composition of all emissions from stacks. The loss of volatile products through leaking packing glands on pumps has been greatly reduced by installing seals of either mechanical or lubricated pressure type. Where the latter are used, individual systems supply oil under pressure to the packing glands of a dozen or more pumps. In single refineries, hundreds of pumps are safeguarded against leakage by these methods.

As for the stacks, on cold days when humidity is high, a plume forms above catalytic cracker unit regenerators. It is mostly water vapor and carbon monoxide, with small amounts of unburned hydrocarbons and catalyst dust. It is visible, however, and therefore taboo under the "no-see, no-hear, no-smell" objective. One refinery has put in a steam boiler that utilizes the carbon monoxide and two other refineries are constructing them. A considerable proportion of the heat required by a refinery can be obtained from this source.

Wherever natural gas or oil is burned, air-fuel ratios are watched closely to insure complete combustion and stacks are fitted with smoke indicators. The antipollution watchdogs also confer with visiting air pollution control representatives and conduct the many surveys they request. (Seventeen of the 96 inspectors of the APCD have been assigned to refineries in recent years.)

By carefully handling smelly substances such as mercaptans and hydrogen sulphide gas, covering skimming pits and sumps and curbing leaks, the refineries have become the most odor-free plants of their kind in America. They are also on the way to becoming the most noiseless. Silencers are applied to reciprocating steam pumps and to the intakes of turbo-blowers serving catalytic crackers. Studies are conducted to suppress all kinds of noise and vibration.

Vapors escape wherever petroleum or one of its liquid products is exposed to the atmosphere. Such conditions exist while crude oil is stored in tanks in producing fields and at refineries while awaiting processing; or while gasoline is in storage or being transferred in open air from one container to another, an event occurring several times between the refinery and the motorist's tank.

One of the approved and accepted control measures in any of these situations is a vapor recovery system that utilizes a compressor. Once collected, the vapors must be disposed of and this usually calls for compressing them. Afterwards, they sometimes can be simply piped to a furnace and burned as fuel, but it is often not that easy to handle them. More frequently, they must be compressed to the pressure of a line that will carry them farther to their ultimate disposal point. This may again be a furnace, or it may be a condenser or an absorption tower where the liquid hydrocarbons are extracted, leaving dry gas that serves as fuel. Where there is no use for fuel gas, it is burned in

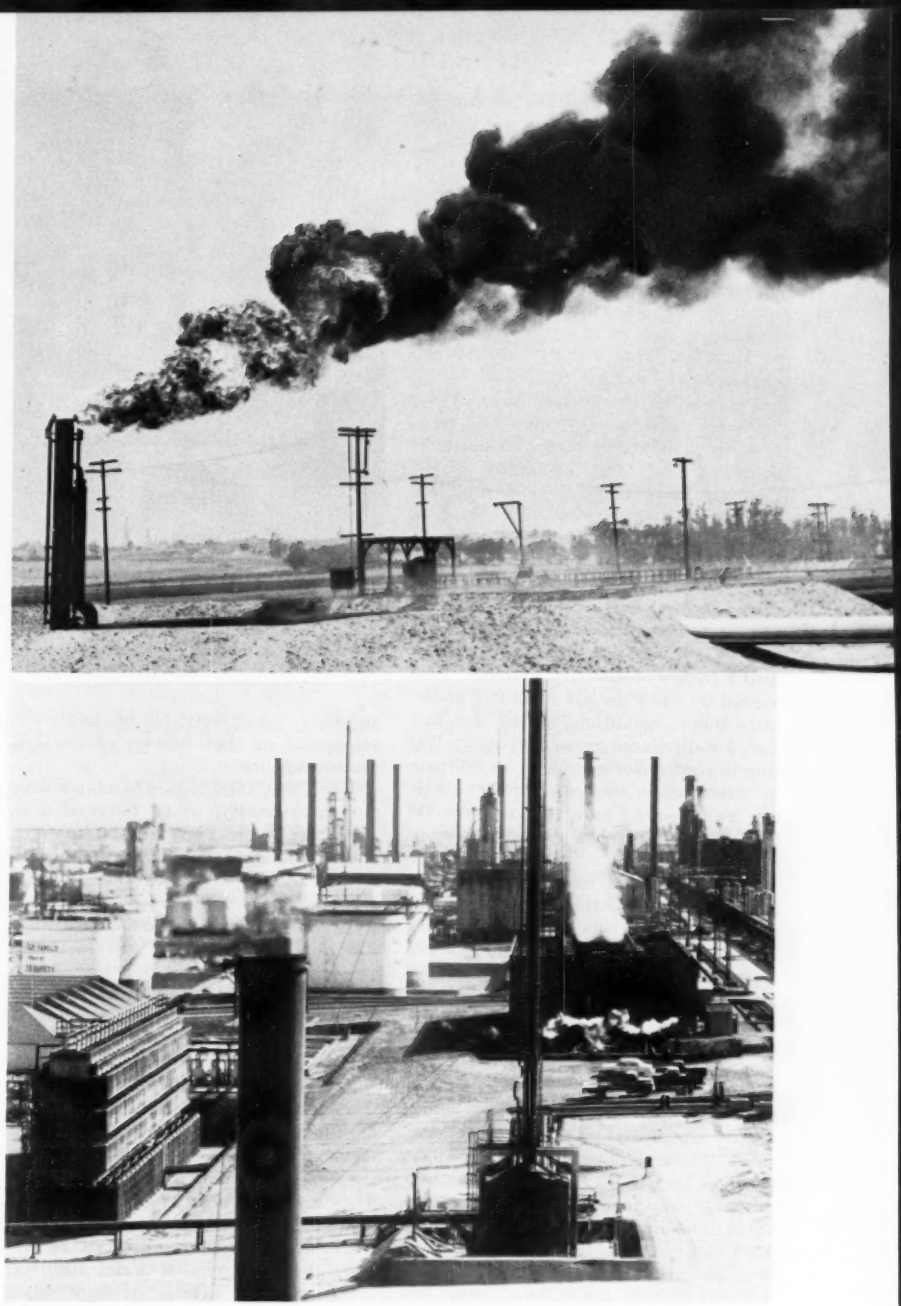
flares that are designed to produce practically complete combustion that releases little or no aerial contaminant.

Regardless of where the compressors are located, their services are similar, but details of the operations vary. We will have a look at some of them, starting at a producing field. There, crude oil, carrying some natural gas in solution, comes from the wells and is piped to a separator where the oil and gas are parted, usually at 50-psig pressure, and each is sent on its way. The oil normally goes into a storage tank at atmospheric pressure and the gas into a 40-psig "low-pressure" field gathering line that likely terminates at a gasoline extraction plant.

There are two main types of storage tanks—fixed roof and floating roof. The fixed-roof type, which is used most because it costs the least, has a stationary roof, as the name implies. The space above the liquid, which varies according to the height of the liquid, is filled with dry gas from an external source or hydrocarbon vapors formed by the flashing of the crude oil. This type of tank has a water seal, and the pressure is held to plus or minus 1 inch of water. Flashed gas eventually builds up pressure and, if not collected, will escape from the tank through the water seal. The vapors, being rich in relatively heavy propanes, butanes, etc., will settle to the ground and constitute an extreme fire hazard. If collected and refined, their product soon pays for the cost of a compressor installation.

The pressure will rise and vapor will be lost when more liquid is added to the tank (filling loss) or when rising temperature causes the vapor to expand (breathing loss). A study by APCD indicated that an average (80,000-barrel, 80-foot-diameter) cone-roof tank containing motor gasoline will lose an average of 930 barrels in a year through breathing loss and 600 barrels from filling loss. The latter figure varies considerably as it depends upon operating conditions and the composition of the product stored.

The normal temperature variation in 24 hours in the Los Angeles area is around 20°F. In an enclosed tank of vapor it may range as high as 40°F. As it warms up in the morning, the gas expands until its pressure overcomes the vent setting and some of it flows out and into the vapor-recovery system. Conversely, in the cool of the night, the gas in the tank contracts and produces a partial vacuum in the space above the liquid. When the vacuum exceeds that for which the vent is set, the latter opens and the tank "breathes" in. To prevent the formation of an explosive mixture of air and hydrocarbon gas, there is normally a connection to a source of dry gas, and this is run into the tank.



CONTRASTING FLARES

Refineries formerly burned gas for which they could not find a use in smoke-producing flares (top). About the only time there is gas to be flared now is when something goes wrong temporarily with the plant process. Even then, it is burned so as to obtain practically complete, smokeless combustion. In the left foreground of the bottom view is a new-type flare in operation at a Union Oil Company of California refinery. No plume is visible; in fact emissions from the entire plant are confined to a few wisps of water vapor.

In the floating-roof-type tank, the roof floats on the surface of the liquid and a flexible seal is maintained between its edge and the tank wall to prevent the loss of hydrocarbons through evaporation. As there is little space in which gas can accumulate, there can be little expansion from diurnal temperature rises and consequently only small hydrocarbon losses. There are also pressure vessels for storing gases such as propane and butane in liquefied form and liquids of high vapor pressure such as natural gasoline. Such vessels do not ordinarily release any vapor to atmosphere.

Most of the compressors on vapor recovery service have been supplied by Ingersoll-Rand Company and are of various types and sizes. As field compres-

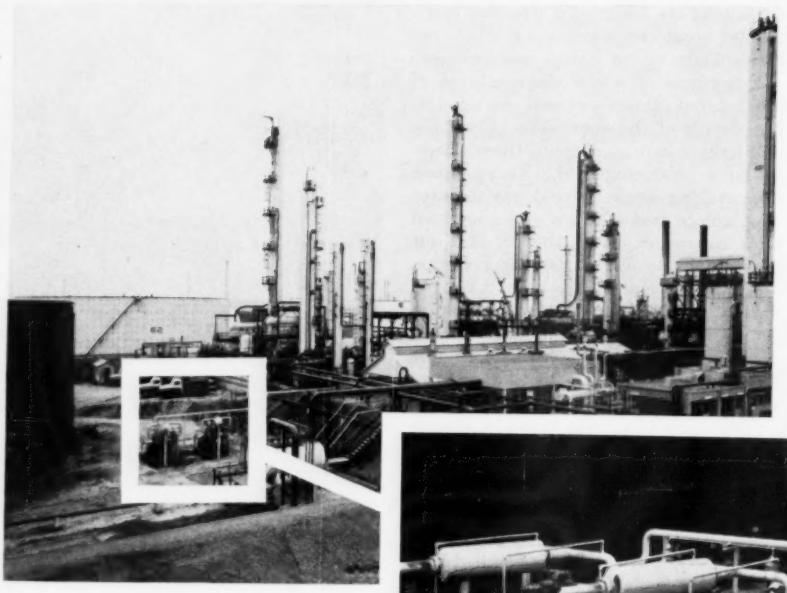
sors are likely to be shifted to new locations now and then, they are preferably compact, fairly small, and mounted, complete with driver, on a steel base or skid for easy moving. For larger capacities, the Class ES straight-line unit, driven by V-belts from a motor, is usually specified. In industrial service, such machines are cooled by circulating water through the cylinder jackets with a pump, but here it is done with absorption oil, using a thermo-siphon circulatory system.

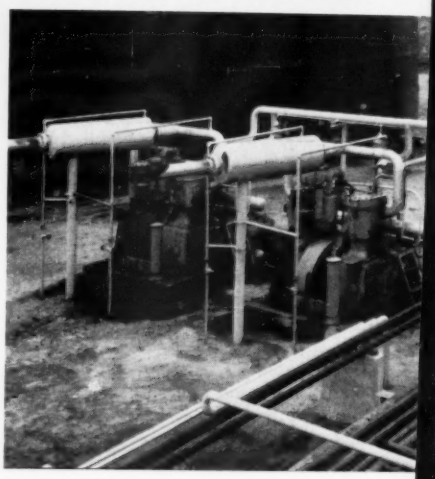
For handling smaller quantities of gas, Ingersoll-Rand has developed four sizes of a wet-gas lightweight, air-cooled compressor. They are "packaged" units, mounted on steel skid bases complete with driver, which may be a motor or an engine run with gasoline, gas or oil. Two models are illustrated. One is a single-stage unit for continuous operation at discharge pressures up to 50 psig and intermittent service up to 55 psig; and intake pressures varying from 2 to 7 inches of mercury vacuum. The second unit is a 2-stage machine for the same intake conditions as the first one and for discharge pressures up to 200 psig in continuous service or to 220 psig in intermittent service. Either model can be furnished as a single or double unit. The latter has two compressors and one driver.

The gas that is handled is "wet"—it contains hydrocarbons that may condense into liquid when compressed and cooled. The compressor cylinders are arranged in horizontal position and the discharge valves are located in the bottom of the cylinder head, which is the reverse of normal design. This arrangement permits small amounts of liquid to pass through the cylinder. Suction scrubbers with high-liquid-level shutdowns are always included to remove slugs of liquid. Special cylinder lubrication is sometimes required. The units operate continuously and have inlet valve unloading in some cases where high dead-end vacuums are objectionable for long periods of time.

Every refinery has a tank "farm" for storage of crude oil awaiting processing and various liquid products of the refining process. As these tanks are commonly of the fixed-roof type and subject to hydrocarbon losses, they are equipped with vapor recovery systems. A large refinery has enough tanks to call for the use of one or more sizable stationary compressors.

Convincing evidence that vapor recovery is an old story in the leading refineries is found in a compressor installation in the Watson refinery of Richfield Oil Corporation. It consists of six Ingersoll-Rand stationary units that have been installed during a span of 30 years. Four types of compressors are there. Three represent different models of gas-engine-driven compressors,





and they, collectively, epitomize the development of that branch of the I-R compressor line.

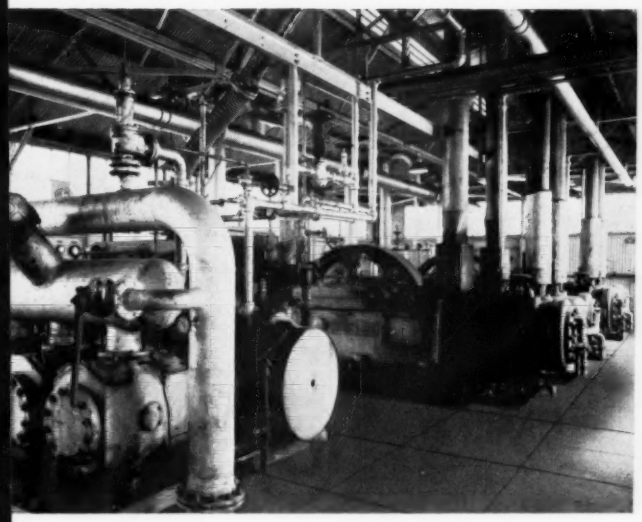
Two Type XOG 160-hp machines were put in originally, to be followed soon afterward by two Type XG 200-hp units. In 1952, a Type JVG 220-hp compressor was added. These are all gas-engine-driven models. The latest addition, a Type HHE 600-hp turbine-driven unit, was put in in 1957. These machines aggregate 1540 hp, all of which is expended in the recovery of vapor from storage tanks. These tanks hold from 40,000 to 100,000 barrels each and there are enough of them to accommodate the cargo of one of the largest tankships.

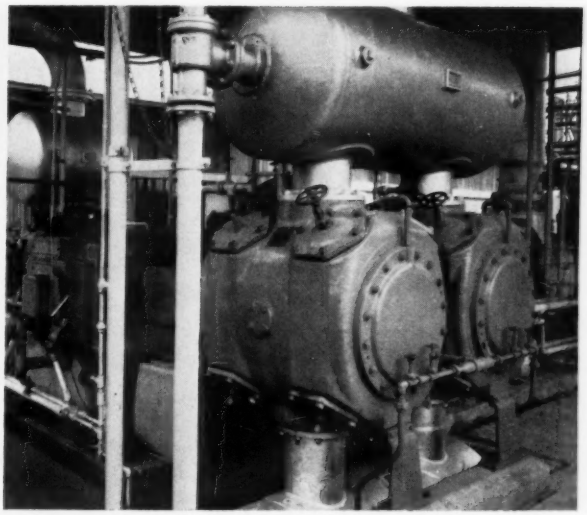
The tanks are set to vent when an interior pressure of ½ inch of water is reached. A gathering system delivers the vapor emissions to the compressors. They discharge it at about 60-psig pressure and send it to an absorption tower, where it rises and is absorbed by descending oil. Any that is not absorbed is burned under boilers. At night, when the tank vapors contract and the tanks breathe in to fill the vacant spaces, natural gas is run into them.

The Type HHE compressor is driven by a Terry turbine that utilizes previously wasted steam at 15-psig pressure from noncondensing turbines. The escaping steam, containing no hydrocarbons or other pollutants, formed a white plume when released and this caused some of the public to think, mistakingly, that it was contaminating the atmosphere.

Other refineries use compressors similarly to recover vapors. For example, Union Oil of California's establishment has an I-R 300-hp machine at either end of the building area. One is a gas-driven Type XVG and the other a steam-driven Type XPV. They recover mainly gas that escapes to either of two holders when something goes wrong in the processing cycle. It was formerly burned in flares until the trouble was corrected, but now only a large upset causes this to be done. Texas Company is installing two 300-hp motor-driven HHE's to operate automatically on this service and supplement the existing gas-engine units. Standard Oil of California has four Class FS steam-driven and two Class ES belt-driven units, each of 100 hp; General Petroleum Corporation has three Class ES 100-hp machines; Shell has four Class ES 125-hp models; and each of the following independents has one Class ES: Hancock Oil Company, Fletcher Oil Company, Century Oil Company, Calstate Refining Company and Wilshire Oil Company of California.

In general these compressors, and in fact all compressors that recover vapors from tanks regardless of location, are loaded to capacity only a small part of the time. In the morning, when the temperature rises rather quickly, vapor forms rapidly and the compressor load rises sharply to a peak. The compressor installation is made large enough to handle this peak load, even though it lasts





VAPOR RECOVERY AT RICHFIELD REFINERY

Vapor recovery at the Watson refinery of Richfield Oil Corporation utilizes six Ingersoll-Rand compressors aggregating 1540 hp. The first ones—two Type XOG, 160-hp, gas-engine-driven units put in 30 years ago—are shown in the square in the picture at the far left and also in the closer view at the left. In the background of the far left illustration is the absorption plant where the vapor recovered from oil tanks is processed. The building in the center houses the four other compressors. Three of them—all gas-engine-driven—are shown (center). A Type JVG 220-hp unit is in the foreground and two 200-hp Type XG's are at the right. The most recently installed machine, a 600-hp Type HHE, is pictured at the right. The latter compressor installation itself helps in keeping clean air because it is driven by a Terry turbine that uses steam that was formerly wasted.

a comparatively short time and is not normally approached closely again during the remainder of the 24 hours.

Gasoline is distributed from the refineries to consumers by a combination of pipelines and tank trucks. At intermediate locations in the system are additional storage facilities and tank vehicle loading equipment. A recent survey showed 98 separately located loading facilities at refineries, bulk terminals and bulk plants and fifteen at airports. About 90 percent of the gasoline loaded out by these 113 installations comes from 27 refinery and bulk terminal installations. About 7500 retail service stations and 10,000 consumer account outlets are supplied, mostly by tank vehicles.

The volume of vapor produced during the loading of a tank vehicle, as well as its composition, is influenced by the type of filling used, i. e., splash, submerged or bottom. In splash filling, the outlet of the filling tube is above the liquid surface during all or most of the filling. In submerged filling, the filling tube is submerged during most of the filling. In bottom filling, the loading hose is connected to a nozzle below the liquid surface of the tank. Splash filling naturally generates the most turbulence and therefore more hydrocarbon vapors. Vapor losses are least with bottom filling which, however, because of its cost, has been applied only at some aircraft filling stations. Losses from filling tank vehicles have been determined experimentally as from 0.1 to 0.3 percent of the volume loaded. Assuming 6,000,000 gallons being loaded daily, the loss would range from 15 to 45 tons, or, say, 30 tons, to take the average. The losses from loading tankships, tank cars, service station tanks and automobiles probably add 60 tons, for a total of 90 tons daily.

Rule 61 of the APCD regulations prohibits loading gasoline into any tank truck or trailer unless the hydrocarbon vapor or gas loss to atmosphere is prevented by a vapor collection and disposal system or its equivalent. When loading is done through hatches, the loading arm must be equipped with a pneumatic, hydraulic or mechanical means for forcing a vapor-tight seal between the vapor collecting adaptor and the hatch. This rule applies to facilities that load 20,000 or more gallons a day.

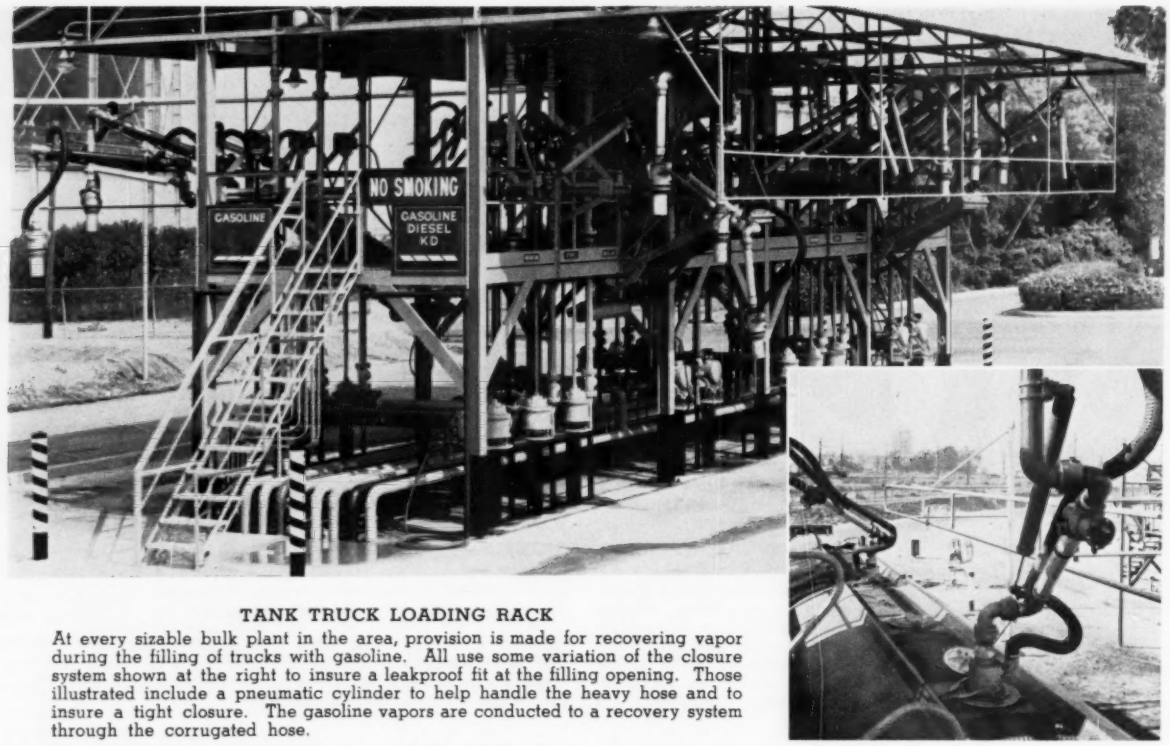
The vapor disposal portion of the system shall consist of, first, a vapor-liquid absorber system sufficiently efficient to recover 90 percent by weight of all hydrocarbon vapors or gases entering the system; and second, a variable vapor space tank, compressor and fuel gas system of sufficient capacity to handle all the hydrocarbon vapors and gases from the vehicles being loaded.

The first vapor recovery unit at a gasoline loading rack was installed and put into operation in 1954 by Superior Tank & Construction Company of Los Angeles, for Standard Oil Company of California at its Clearwater bulk terminal. This unit was the prototype of the present day Superior "Vapor Saver" that will be described later. A truck hatch vapor enclosure of lucite (to permit observation of the filling) and synthetic rubber was developed and constructed. It was self-sealing, requiring no external hydraulic or pneumatic cylinders. Later developments resulted in the SOCO vapor closure that has been accepted throughout the industry.

Two other pioneer loading rack installations were made in 1955 by General Petroleum Corporation, one at its Torrance refinery and the other at its Vernon bulk terminal. Two Ingersoll-Rand Class ES compressors driven by V-belts from a motor are used at each location, one of 200-cfm and the other of 450-500-cfm capacity. Tank trucks are loaded at the rate of approximately 500 gpm through a 3-inch line that enters the manhole through a lucite hood having at its bottom a tapered plug to fit into the opening. To insure a tight fit, the plug is covered with neoprene Hycar rubber. The hood is closed at the top by a telescoping vapor recovery compartment from which a suction line leads the vapor. An air-operated piston lowers the loading arm and keeps the plug firmly in place in the manhole.

When a truck is being filled, the vapors are displaced and forced upward into the hood and thence out the suction line. From the latter, they pass through a 2½-inch quick-opening valve to a header that is connected through a pressure controller to the suction of the compressors. This valve and the gasoline filling valve open and close simultaneously.

During normal filling operations, the vapor header is controlled at around 2



TANK TRUCK LOADING RACK

At every sizable bulk plant in the area, provision is made for recovering vapor during the filling of trucks with gasoline. All use some variation of the closure system shown at the right to insure a leakproof fit at the filling opening. Those illustrated include a pneumatic cylinder to help handle the heavy hose and to insure a tight closure. The gasoline vapors are conducted to a recovery system through the corrugated hose.

inches of water pressure by a motor valve. The control system, which was designed in part by General Petroleum engineers, is arranged so that the smaller compressor handles the load as long as it can, with the larger machine cutting in when it is required. This is accomplished by means of interconnected vacuum-pressure switches. Each compressor is also equipped with unloaders that function in response to changing pressure conditions.

The smaller compressor at Vernon is a Class ER 15-hp, 10x5-inch unit and the larger one is a Class ES 30-hp, 10x9-inch. The collected vapors are compressed to approximately 6-psig pressure and burned as fuel under steam boilers. The two machines at the Torrance refinery are both Class ES models, the smaller one a 30-hp, 15x9-inch size and the larger one a 60-hp, 14x11-inch unit. They compress the collected vapors to 45-psig pressure and put them into the refinery fuel gas system.

The compressors at both places are equipped with bottles on their suction and discharge lines to dampen pulsations. All machines are cooled by thermo-siphon systems that circulate absorption oil.

A "packaged" vapor recovery system designed to capture gasoline vapors at loading racks and convert them into a more stable saleable product is produced by Superior Tank & Construction Company. It was developed by the firm's chief engineer, Albert H. Tompkins, Jr., and his staff. Called the Superior Vapor Saver, it is a compact, complete unit. All of it except a Vaporsphere gas holder is assembled on a structural steel base and can be moved to a working location and put into operation in a matter of hours. Several major oil companies have from one to five of them and there is a total of fifteen in service in the smog-afflicted area.

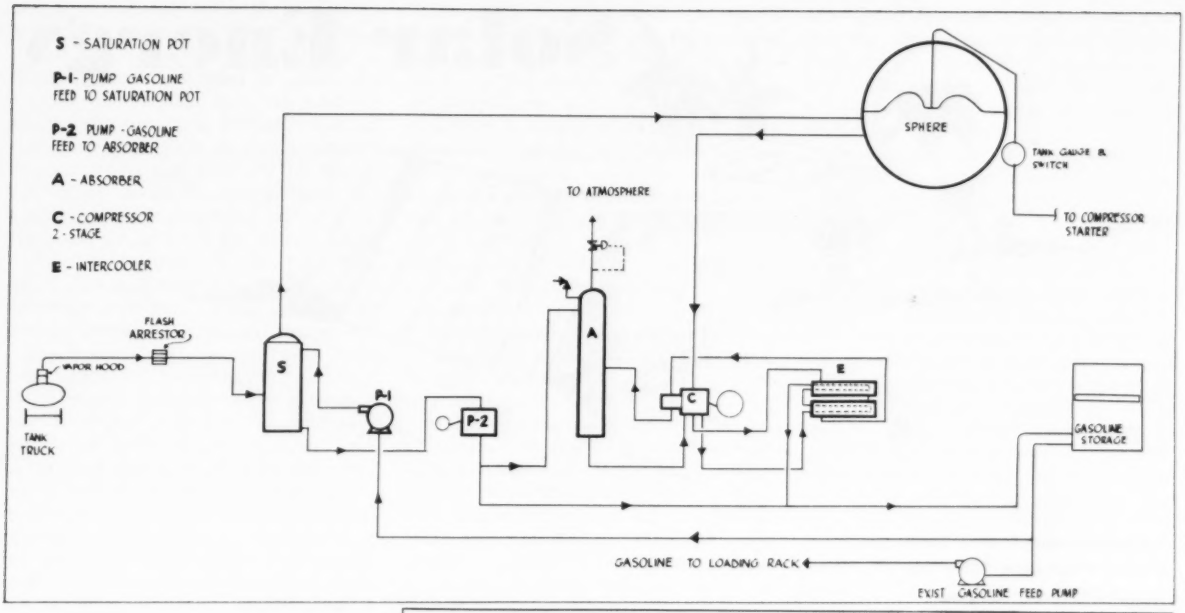
Superior is perhaps the oldest hand in the industry at this sort of thing, having started building oil field vapor recovery systems in 1927. They were sold strictly on an economic basis and some of them paid for themselves in from 45 to 90 days. The experience gained then led to the development of the present system. Several different arrangements of handling the recovered vapor were tried with only partial success and finally the present scheme of using an absorption tower was adopted.

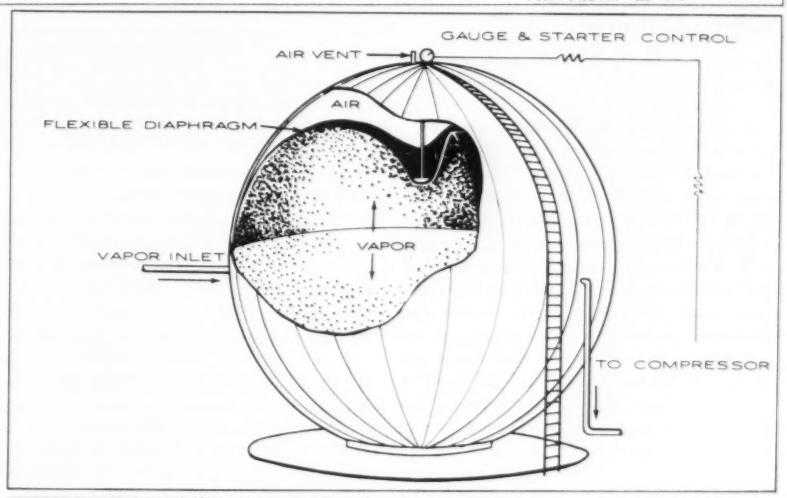
An accompanying flowsheet shows the components of the system and the operating cycle. The gasoline-vapor and air mixture is collected from truck loading racks by means of suitable headers and conducted to a variable-volume gas holder. This is a spherical vessel with ingenious features. Inside is a synthetic rubber and nylon diaphragm that permits varying the volume of the storage space. The vapor is piped in below the diaphragm. The diaphragm keeps it under slight pressure and prevents outside air from mixing with it. As a safeguard against explosions, the vapor-air mixture is passed through a saturation pot, where the air is completely saturated, before going to the Vaporsphere.

When a sufficient volume of vapor-air has been collected in the holder, the system starts operating. The mixture flows to the intake of a 2-stage reciprocating compressor that compresses it to 200-psig pressure and delivers it to an absorber. The compressor operates within adjustable limits of 20 percent and maintains, whenever possible, a substantially empty holder. The holder supplies vapors to the system at a constant rate within the limits of its capacity, thus reducing the frequency of the starts and stops of the compressor.

Motor gasoline taken from storage is pumped from the saturation pot into the top of the absorber at a predetermined rate. It counterflows the rising vapor-air mixture. The gasoline vapor is absorbed by the gasoline, which is removed and piped through the compressor intercooler to cool the gas after it is compressed. The gasoline then goes to storage.

The flow is controlled so that gasoline is pumped to the saturator while vapors are being delivered from the loading racks. The compressor is also interlocked with the two process gasoline pumps so that it cannot operate independently, thus eliminating the possibility of malfunction. Adequate safety shut-off controls with visual and audible alarms prevent the completely automa-





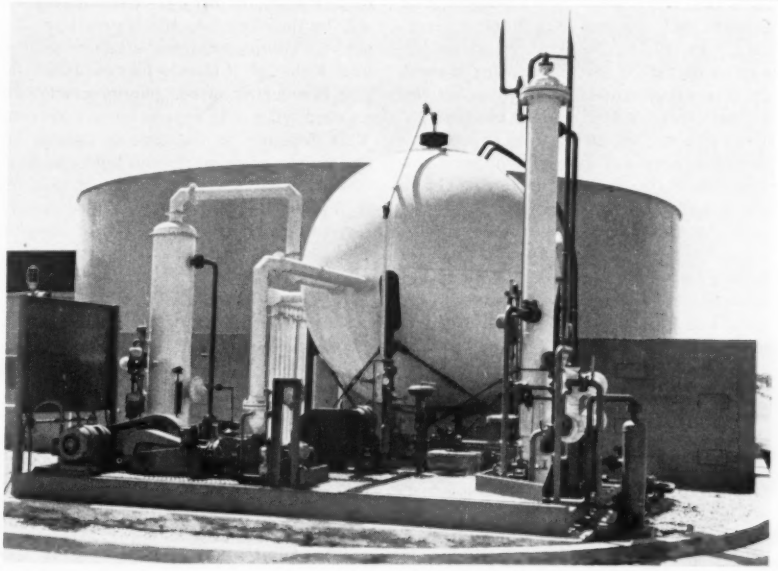
PACKAGED VAPOR SYSTEM

The outgrowth of experience that goes back to 1927 is the Vapor Saver of Superior Tank & Construction Company. The installation shown at the lower right—one of four at the Los Angeles International Airport—is owned by American Airlines. It takes vapor from an adjacent loading rack where tank trucks are filled from underground gasoline storage tanks. Except for the Vaporsphere, the equipment is all mounted on a structural steel base and can be moved and put to work in a few hours. The Class ES, 2-stage compressor that is standard with the outfit is shown at the left end. A flow sheet of the Superior system is shown above. Note that gasoline from the absorption tower is used for cooling purposes in the compressor cylinder jackets and intercooler where water is normally employed. At the right is a section through a Vaporsphere.

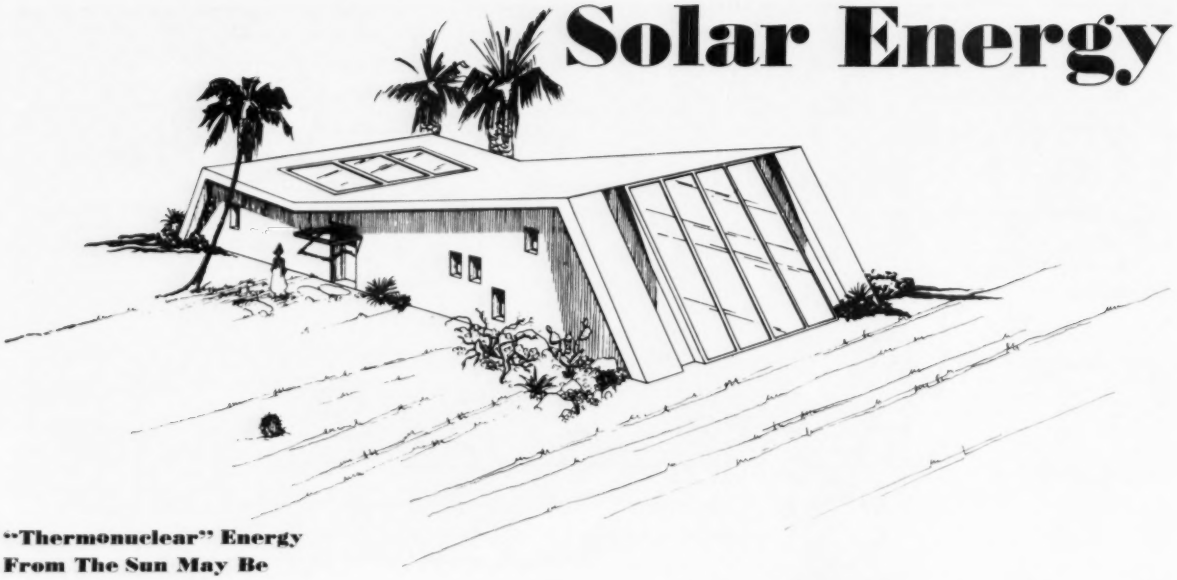
tic process from operating when conditions are abnormal.

The compressor is an Ingersoll-Rand Class ES, driven by static-resistant V-belts from a motor. It is arranged for bottom discharge, has lubricated metallic packing and is furnished without intercooler because the latter is a special and separate apparatus designed for using gasoline as the coolant. The size of compressor varies with the capacity of the Vapor Saver and ranges from the 7&3⅛x5-inch Class ER-2 machines to the 11&5x11-inch Class ES-2 and even larger.

The Vapor Saver is made in five sizes, with capacities for handling the vapor produced in loading from 160,000 to 700,000 gallons of gasoline a day. The spherical holder is supplied in any one of three sizes ranging in capacities from 10,000 to 20,000 cubic feet. Special sizes are available to meet any requirement.



Solar Energy



"Thermonuclear" Energy From The Sun May Be Man's Next Great Source Of Power

G. R. Smith

LOW-COST SOLAR HOME

An "austerity model" of a solar house is this one built as an exhibit for a U. S. trade fair in Casablanca, Morocco. Designed by Phoenix consulting engineer, John I. Yellott, and Charles M. Shaw Associates, this house collects sunlight with the four slanting panels in the wall at the right of the sketch. Heat is stored behind the collectors in a pile of rocks. The panel sections in the roof of the building, at the left, heat household water. The total cost of the structure was about $5000.

WHEN the ancient Greeks thought the sun to be the god Phoebus, daily coursing his gold and silver chariot across the heavens, they somehow must have sensed the tremendous power of the great, white-hot orb. Scientists today well know the power of the sun, and as they squint upward at that star, they are becoming increasingly more anxious to harness the vast potential of solar energy.

The scientists, of course, have some facts that the Greeks didn't possess. It's known that the sun is a huge gaseous body, and that at a given point on the earth's surface, a certain amount of energy is received from it. However, at the present state of science and technology, finding how to make direct practical use of this energy is perhaps more elusive than the fastest mythical Greek chariot.

Why, then, is there interest in putting the sun's rays to work? The fact is, we may soon run out of other types of energy. For several hundred years, man has been using the sun's power—as stored by the plant growth process of photosynthesis—at an alarming rate. This reservoir, in the form of coal, petroleum, natural gas, oil shale, peat, etc., took millions of years to accumulate. It is sure to run dry eventually; predictions of when that will be are as plentiful and varied as the persons making the forecasts. Further, the prophets can't accurately estimate such factors as future consumption rates or the size of yet undiscovered reservoirs. However, the more pessimistic estimates allow for only about another 150 years of fossil fuel supply at the apparent constantly increasing rates of consumption.

In the over-all energy picture, power supplied by hydroelectric and tidal waters amounts to only a small fraction of the world's needs and can't be seriously considered. Nuclear power, on the other hand, is an unknown, but highly potential, quantity. Presumably, it will be developed in the immediate future to complement our fossil resources and, although it should last many years, just how many of our energy needs can be met with this source, is not known. This depends, in the case of fission, on the supply of uranium and how efficiently it can be expended. Nuclear fusion, if it can be controlled, could possibly provide an inexhaustible power supply. However, at this early stage, fusion can scarcely be mentioned with other types of man-controlled energy.

The fascination of solar energy is that it cannot be depleted. It undoubtedly will provide power as long as man is able to survive on earth.

The sun produces light by fusion as its hydrogen is converted into helium. The quantity of heat produced is estimated by one astronomer to be great enough to warm 2.2 billion earth-like planets.

The sun's energy must first be collected to be usable; then, because of its intermittent nature, it often is necessary to store it. Collection can be by heat-absorbent flat-plate collectors, or by concentrating devices such as mirrors, that make immediate use of the heat. It can be stored in water, piles of stones or certain chemical salts. Other more complex modes of collecting and saving the energy are photosynthesis, the manner in which the earth's vegetation collects the sunlight; and certain photochemical and photoelectrical processes, such as those used by solar batteries.

The classic first use of sunlight energy by man, in a direct application, was by the Greek mathematician, Archimedes. It is said that he used a battery of mirrors to focus the sun's rays on the sails of Roman ships that were attempting to attack his native city of Syracuse, Sicily. The invaders were thwarted when their sails caught fire and their vessels burned. It is interesting to note that the Roman sails were of very heat-absorbent black cloth; white sails probably wouldn't have been kindled.

The story may or may not be true, but it does illustrate two of the sun's characteristics that are a starting point for many solar energy problems. First, the total amount of sunlight striking the earth is huge, almost beyond conception. One estimate states that if all the fossil and nuclear fuels ever produced, plus all those that are likely to be produced, were burned at the rate

we receive energy from the sun, they would last for only a little more than 3 days. The second characteristic is that although the total is great, the amount that strikes any one point is small—the energy is diffused over an enormous area. Just above the planet's atmosphere, about 1.35 kw of energy per square meter is received from the sun; because of reflection and absorption, only about 1 kw per square meter reaches the surface in the temperate zone. This indicates that the power source may be ideal for individual small energy needs, but may not be so well suited to large ones because of the huge collecting areas necessary.

The study of solar energy, now getting underway in earnest, is taking several major paths of development. One of its chief uses is for heating and cooling of homes, and in some cases, larger buildings. There are many other applications, however, that eventually may surpass that application. An example is the solar furnace, at present the only means of maintaining temperatures of more than 6000°F for periods of several hours. Several U. S. corporations and schools have these devices, many being built from surplus military searchlights. Solar cookers are another version of the same idea that are used at lower temperatures for food preparation. Solar water heaters are often included in homes that use sun for heat. Solar stills are envisioned as an economical answer to the great heat requirements of distilling fresh water from salt sources.

One of the most interesting advances is the solar battery in which silicon crystal cells convert heat directly into electricity. The power that U. S. earth satellites draw upon to operate their remote radio transmitters is supplied by these half-dollar-sized cells, collecting the sun's light in an unobscured view. They now operate radios, clocks, counting gadgets, lighting systems, alarms, traffic controls, light-measuring devices and even tiny hearing aids incorporated into the frames of eyeglasses. Once expensive and available only singly or in small numbers, mass production has caused their production cost to drop, and now they may be ordered in lots of hundreds or thousands.

Massachusetts Institute of Technology ushered in the adolescence of the United States study of the sun's energy in 1939 when the school built its first solar-heated house. Recently, the fourth such MIT-sponsored structure was erected. Located in Lexington, Mass., it will obtain about 75-80 percent of its thermal requirements from the sun. It uses water to accumulate heat collected by an expanse of 640 square feet of aluminum sheet, 0.025-inch thick and painted black. The sheet, covered by two layers of glass to retain heat, much as does a florist's greenhouse, spreads over the roof and south wall of the 2-story, 3-bedroom dwelling. The heated water is carried through copper tubes to a 1500-gallon tank. Air heated in a heat exchanger then moves through the house. An auxiliary oil furnace takes over when the sun's activity wanes during the bitter Massachusetts winters. Built by a team of MIT engineers and architects, it will be sold, though the school will retain rights of access to recording instruments.

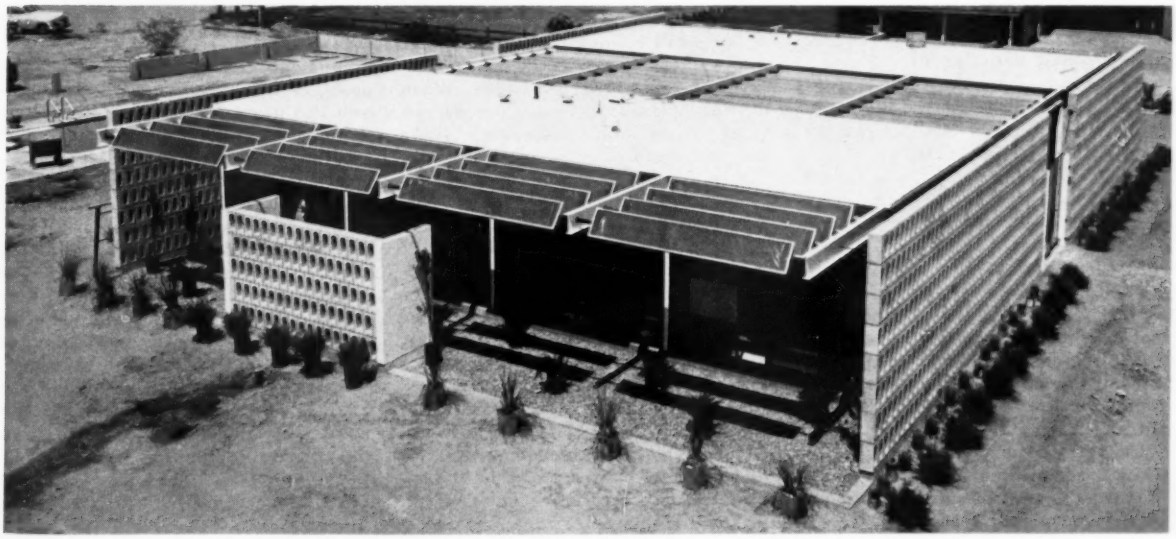
Another sun-heated house was built recently to serve as a working laboratory for solar energy research. Erected in sunny Phoenix, Ariz., it was designed to obtain all of its heat from solar radiation. Phoenix is the headquarters of the Association For Applied Solar Energy (AFASE), a nonprofit group formed in 1954, with major support from the Stanford Research Institute of Menlo Park, Calif. The Association, now a separate body, gathers and disseminates information on all phases of solar energy.

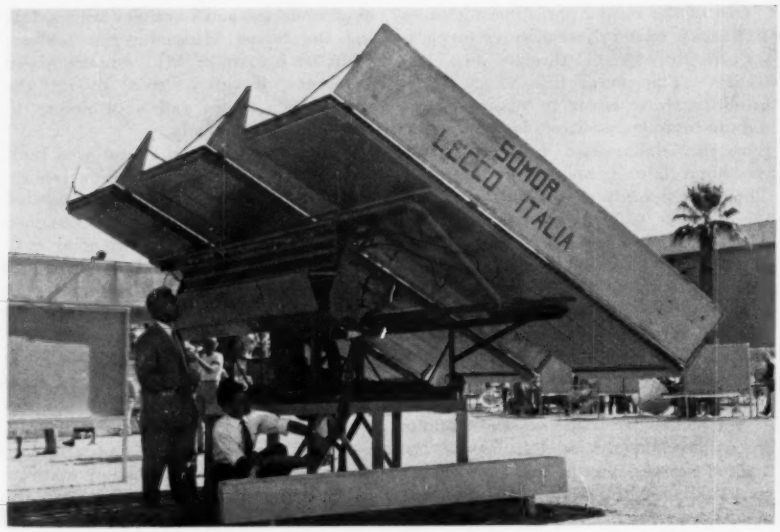
One of the first activities of the group was to hold an international symposium in 1955 for scientists interested in the subject. Delegates numbered about 1000 and 37 countries were represented. The results of these discussions were published by AFASE in the *Proceedings of the Phoenix Symposium*. The world's first scientific periodical on the sun's power, *The Journal of Solar Energy Science and Engineering*, is now issued four times each year by AFASE.

The elaborate, $60,000 Phoenix Structure incorporates the newest in solar heating and cooling design. It resulted from a competition held during the summer of 1957. Following inquiries from some 1600 architects, 126 entries were accepted from a total of 13 countries. The winner, selected by five outstanding

PHOENIX SOLAR HOUSE

This 3-bedroom house was built near Phoenix, Ariz., by AFASE following an international design competition. Peter Lee, a University of Minnesota senior in architecture at contest time, supplied the winning plans for the $60,000 dwelling, completed in April 1958. The home is the first in America to be completely heated by the sun's energy; electricity operates its heat pumps to cool it in summer. Several rows of louvers, that collect sunlight and transfer heat to circulating water, can be seen in this southern view. The louvers are automatically maintained at the angle that allows them to best use the sunshine. At the extreme left, a portion of the swimming pool is visible; it acts as a secondary water storage tank and as a heat dump for the summertime cooling system.





THREE SOLAR MACHINES

These photographs show existing applications for using the sun's rays. The picture above depicts a sun-operated engine that is the only commercially produced solar engine built today. Manufactured by Societa Motori Recuperi (SOMOR) of Lecco, Italy, it is designed for pumping water in areas with abundant sunshine but little fuel. Light collected on the large flat plate heats a low-boiling-point liquid. The resultant vapor drives a 1-cylinder engine of about 1½ hp. The vapor is then condensed and returned to the collector. In this view, the engine, visible below the heat exchange tubes, is not connected to a pump. At the right is a solar furnace. Use of surplus military search-lights, such as this one, by B. F. Goodrich Company, is a common method for devising such a unit. The light's parabolic mirror concentrates sunlight to a spot about ⅜-inch in diameter. The extremely high temperatures attained are used for studying materials subjected to the intense heat. Here, a member of the Goodrich Research Center staff shows where the sample will be positioned. Atop the searchlight are electronic controls that keep the mirror at the correct angle to the sun. Larger furnaces, such as those built on Mont Louis, France, have mirrors many times the size of this one. The portable solar stove (above, right) collects the sun with a mirror also, but uses the heat for cooking. This particular cooker, developed in Beirut, Lebanon, shows the world-wide interest in putting the sun to work for man.

North American architects, was Peter Lee, a senior at the University of Minnesota School of Architecture.

Completed in April 1958, this house collects heat by means of long, aluminum louver shells stretched on wooden frames. Dacron batting insulates the aluminum, and blackened copper Tube-in-Strip rests on the batting. The copper absorbs the sun's heat, transferring it to the water that circulates through its small tubes. Covering the copper are transparent sheets of Mylar plastic through which shorter-wave light energy may pass, but that prevent longer heat waves from escaping by radiation. Sixty-eight of the louvers, mounted in seventeen parallel rows above the house's two patios and a central court, warm the house and the domestic water supply. Clock-controlled motors turn each bank of louvers to face the sun. An insulated 2000-gallon tank, buried at the edge of the house, and a swimming pool with a 21,000-gallon capacity, serve as water storage areas. Two electric heat pumps circulate air through the house. When thermostats indicate heat is needed, hot water moves from the storage tanks through coils on the heat pump intakes. In the summer, the same system becomes a cooling unit. The black louvers are inverted and the bright aluminum under-surfaces reflect heat and provide shade. Cool water, taken from the storage tank, lowers the temperature of the air within the house. The heat added to the water is dissipated by sending it to the swimming pool where cooling sprays are at work.

There are two wings separated by the central court; each is 18 feet wide and 48 feet long. Tinted solar-gray glass in the windows gives the home the appearance of "wearing sunglasses"—it softens the intense Arizona sunshine as well as providing privacy. Like the MIT house, the structure is completely instrumented for scientific recording purposes. A pneumatic Minneapolis-Honeywell Btu meter will measure and record the amount of solar heat collected, and precision pyrometers will enable temperatures to be measured throughout the entire system. After approximately 2 months performance, the house was said to be functioning successfully. Some minor trouble had been experienced with adjustment of the louvers, and the possibility of installing a compressed air system in place of the electric-motor mechanical-linkage one has been contemplated. The air system would utilize an instrument air compressor to operate power pistons to turn the louvers up in the morning and down at night.

At the opposite end of the cost scale is a solar house just built in Casablanca, Morocco, as part of a United States

exhibit at an international trade fair. This home, described as an "austerity model," cost about $5000—roughly the expense of the heating-cooling unit in the Phoenix house. Four aluminum collectors, in the out-sloping south wall, collect heat, which is then transferred by air, for storage, to cylinders filled with rocks. Domestic water is heated by two smaller collectors in the flat roof of the north portion of the home.

Though research in solar energy is receiving increasing interest, the number of the world's solar scientists is not impressive. John I. Yellott, Phoenix consulting engineer and former executive director of AFASE, estimates that there are less than 1000 scientists actively working on the subject. One of the main problems confronting these researchers is the discovery of a better method to store the sun's energy. Water requires much auxiliary equipment and space. The disadvantages of a pile of rocks are obvious. Salts, that release heat upon crystallization following melting at a temperature slightly above room temperature, present problems when used in large quantities. Batteries are not feasible for large power demands, either.

Other problems needing research include the design of more efficient collectors so that more of the available sunshine is gathered; and the finding of collector surfaces that will absorb the sun's rays while not radiating thermal energy. Although the black surfaces that now function as collecting faces are good, they have the drawback of being excellent for radiating energy as well. Still another problem is learning how to produce larger silicon cells for battery uses.

Almost all these are directly related to economy. Until the cost of solar heat can be lowered to approximately the expense of conventional fuels, it will never receive widespread use. At present, the cost of a solar heating plant is usually four or five times greater than a normal heating unit. Probably not until the cost is reduced to about twice that of the ordinary installation, will solar types be used, the extra expense being tolerated because of lack of fuel costs, added cleanliness and little maintenance.

Because the sun's energy has no apparent use as a military weapon—burning of sails no longer being considered of tactical value—the science has not felt the impetus often given to fields with defense applications. One estimate puts the annual total of research funds spent on solar energy in this country at only about $1,000,000—not large for a field its size.

Along with the AFASE and MIT studies, however, work is being carried on in several locations throughout the world. Dr. Farrington Daniels' work at the University of Wisconsin is highly regarded, and other research is done at Stanford Research Institute, Arizona State College at Tempe, University of Arizona, University of Minnesota, University of Florida, New York University and University of California. Bell Laboratories and Du Pont are also working with solar energy. The U. S. Army and Air Force both have specialized projects.

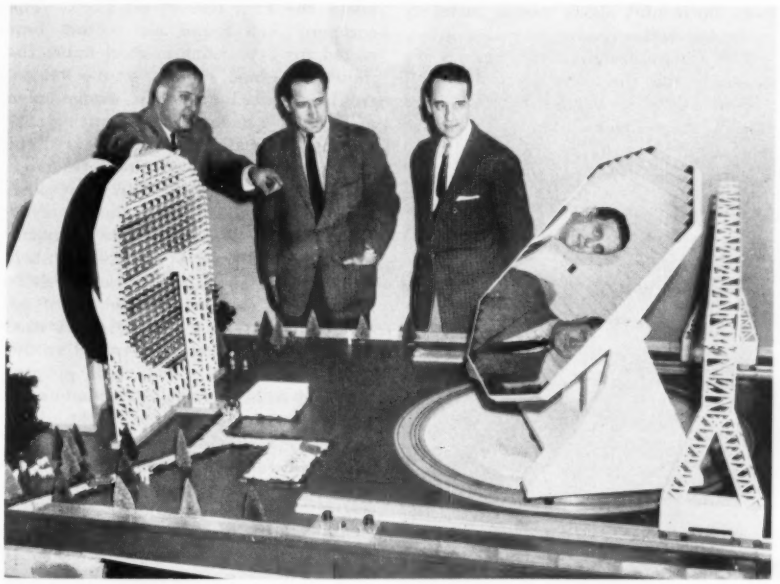
The Russians are thought to be far advanced in the field. They reportedly have a huge, sun-powered electric generating plant under construction near Mt. Ararat in what was formerly Armenia. This installation is thought to be able to produce 2500 kw, while such plants in the free world rarely have more than a 2-kw output. The Russian plant consists of a large boiler surrounded by several concentric rings of railroad tracks. On the tracks are cars mounting large mirrors; the cars circle the boiler automatically so that the mirrors always focus the sun's rays on it. Electric power is then generated from the steam produced.

Another European country distinguished for solar research is France. High in the Pyrenees is Mont Louis, site of the Solar Energy Laboratory of the French Government. Here have been developed large, high-temperature solar furnaces that test materials for research and industry.

The governments of India and Israel are engaged in studies to help their standards of living by use of solar energy. An Italian firm produces the only commercial solar pumping engine in the world. A flat-plate collector absorbs heat that is used to boil sulfur dioxide. A piston, flywheel and condenser convert the vapor into pumping power. The unit is at work only when water is needed —when the sun is out and rain isn't falling. In England and America, scientists are experimenting with sunlight as a means to break down water so that easily stored hydrogen might be obtained. The hydrogen could subsequently produce electricity.

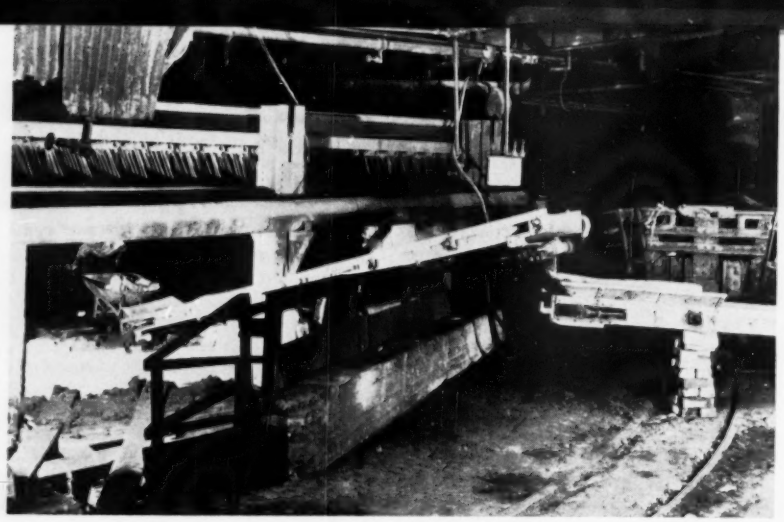
Much interest is shown in putting solar energy to work in sunbathed South America. An oil company in Venezuela is trying to heat pipelines with the sun to reduce viscosity of fuels, which would cut pumping costs. Other countries that show interest in the subject are Peru, Chile, Argentina and Brazil. In Australia, construction is underway on a solar still that will use the sun to produce heat for freshening salt water.

With this increasingly diversified front of research, it appears that the world cannot long hold back the advent of widespread use of solar energy. The potential of this power may easily fashion the coming years into "the solar age," overshadowing even the importance of the so-called rocket or space ages.



MODEL OF LARGEST SOLAR FURNACE

When installed for the U.S. Air Force near Cloudcroft, N.M., the solar furnace represented by this model will be the largest such unit in the world. Its 151-foot-wide heliostat, right, will reflect the sun's rays to the 108-foot-diameter curved focusing mirror, left. A 5-inch "hot spot" will achieve temperatures up to 7000°C for materials testing by military, governmental and private agencies. The shutter-like structure in front of the focusing mirror is a 10-story-high attenuator, the blinds of which will regulate the amount of light reaching the focusing surface. Observing the model are personnel of J.W. Fecker, Inc., the Pittsburgh, Pa., firm that designed the optics and servo-control apparatus.



BRICK HAULAGE

At the left, seen under and beyond the horizontal gas pipe, a wheelbarrow of bricks is about to be dumped into a Farnco conveyor that will deposit the rubble into a second unit at the right of the photograph. Each conveyor allows one man to do the work of three men.

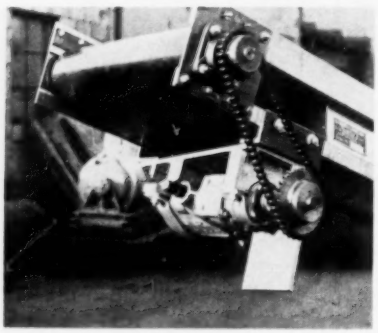
Portable Conveyors Speed Maintenance, Construction

INDUSTRIES, business concerns and builders have learned that a handy and quick method for moving materials is by use of portable conveyors built of strong, lightweight aluminum. Put to work either singly, or in combinations of several machines, these wheel-mounted transporters allow the efforts of a few workers to be multiplied many times. They provide considerable labor cost savings, greatly reduce employee fatigue and bolster morale.

One manufacturer of these aluminum conveyors is the Farnco Sales Company of Pittsburgh, Pa., that constructs the units primarily for use in steel mills, construction and general warehouse work. The three machines in the company's line are basically the same, though strength capabilities and lengths vary, and special units are often built to customer specifications. The conveyor's long box frame is built completely of extruded aluminum alloy. A rubber conveyor belt is moved in a continuous ribbon about this frame, carrying the materials that are to be handled. The company estimates that a conveyor allows a worker to do the combined labor of three men.

The most popular model in the firm's line is the Model SM, a unit built for steel mills. One version of this machine, driven by an air motor, comprises about 90 percent of the firm's sales. It is fabricated with sturdy aluminum frame members, and extra strength is gained from horizontal shock plates installed under the belt.

Two different sizes of air motors are available for the conveyor, one with 2½-hp and the second with 3½-hp. Both of these Ingersoll-Rand motors are operated with 70-80-psig air pressure and normally are mounted under the conveyor head end, the extremity where material leaves the transporter. This position allows the motor to be away from persons loading the machine and keeps the area free of air lines. The company has found air motors best suited for operations in steel mills: the motors are not subject to mechanical troubles caused by dusty, smoke-laden air; abrasive scale or wet operating conditions do not affect them; they are light in weight; and they require little maintenance. Also, installed in their position under the head end of the conveyor, they permit relatively simple balancing of the transporter over the vee mounting to the 10-inch semipneumatic wheels.



AIR-MOTOR DRIVE

This Ingersoll-Rand air motor provides 2½ hp for driving the Farnco Model SM conveyor visible in this close-up. A roller chain from the driver sprocket turns the head shaft sprocket to move the rubber conveyor belt. (The chain guard has been removed to reveal the drive sprockets.) This heavy-duty transporter is commonly used by steel companies during blast-furnace overhaul, and is also valuable for transporting weighty construction materials, such as cement, concrete blocks, sand and gravel.

Available in standard lengths of 12, 16, 20 and 25 feet, the Model SM is used for heavy work often done with an unwieldy wheelbarrow. Its main purpose is to aid in blast furnace overhauling—for cleaning out flues, checker chambers, for moving slag and brick refuse. It is utilized for hauling scale from rolling mills and away from runout tables. Movement of building materials, such as bagged cement, concrete blocks, sand, gravel and roofing, is another use.

A special SM is equipped with a deep hopper at the foot end to receive mixed concrete. Usually designed to customer specifications, this unit has rubber flanges paralleling the frame to keep the mix from the conveyor's operating mechanism and to prevent spillage.

The material handled by this model is heavy, but locating the wheels at the balance point permits easy positioning. These wheels also can be removed, if necessary, to place the conveyor into a small opening. Further, they permit the unit to be towed to the job by a truck, or the truck can haul it. Farnco conveyors may be powered by an electric motor or a gasoline engine, though the Ingersoll-Rand air-motor drive is the usual arrangement.

Somewhat lighter in construction is the Model BC, designed for building contractors. This machine comes in standard lengths of 20, 25 and 30 feet, and its chief uses are movement of brick, tile and block, and transporting such awkward materials as roofing paper, insulation, packaged materials and flat goods. The lift truck, that serves as a V-shaped supporting base, can be adjusted to a steep angle to move the unit close to buildings under construction. Coal, coke and stone of various sizes may be transported, as well as earth, bulk cement, cinders and fertilizers.

The flat-topped Model FT, third in the Farnco line, is often tailored to the user's needs. Its length can be as long as 80 feet and the wide, flat-surfaced belt, having no vertical side panels next to it, allows handling of oversized boxes, bags, etc. Belt cleats permit transport of brick, tile, wallboard, roofing and other building materials up a steep incline to a work site.

The conveyors may have their drives mounted in several positions around the periphery of the belt travel. An air motor placed at the head end is most common; other installations are wrap drive under the frame, line-shaft drive and foot-end drive.

England's Largest Road-Building Project

ENGLAND is experiencing her most extensive road-building program to date; and, if all goes well, it should provide 70 miles of dual highway by September 1959. Construction began on March 24 of this year, contracts having been let to John Laing & Son, Ltd., for its 53-mile-long northern portion, and Tarmac Civil Engineering, Ltd., for the southern section. When the motorway and its approaches are completed, the highway will connect London and the Midlands. Eventually, the entire journey between the Capital and Birmingham will be made over divided highways and will result in a considerable time and fuel savings for motorists.

In an inauguration ceremony speech, it was said that this was the largest single road scheme ever commissioned in England, the total estimated cost being approximately $42 million; and that it was being built to the most rigorous of specifications. The standards being sought will meet those established throughout the world. After the speech, the first concrete slab forming the parapet of one of the bridges was sealed, and an electric switch was thrown sounding a Klaxon. Immediately, an "armoured column" of excavators moved over the southern skyline toward the starting point of the proposed road. Buckets were lowered, and scraping began. Simultaneously, work began at various other points along the route for, in order to meet the deadline, the contractors must build an average of 1 mile of roadbed every 9 days. Since bridges and earthworks must be finished prior to the passing of the new highway, bridges must be erected at a rate of one every 3 days.

When the working force is at its peak, it is estimated that some 3700 men will be required to operate the more than 1000 pieces of road-making equipment. Two aircraft will be on hand to facilitate supervision by John Michie and A. Neville Rawlings, general project managers for John Laing & Son, Ltd., and Tarmac Civil Engineering, Ltd., respectively. These craft will also be used to bring in spare parts for the equipment. More than 8,000,000 gallons of fuel will be required to keep the machinery running, and it is estimated that some 4,000,000 square yards of roadway will be built.

To be known as the London-Birmingham Motorway, it starts south of St. Albans at what will be known as the St. Albans By-Pass. From there, the superhighway will join the main trunk line near Luton, following a northwestern direction across the midland plains to Watford Gap, near Ashby St. Ledgers, Northamptonshire, where a short spur will be constructed to lead traffic toward Birmingham. Eventually, the main trunk will be continued to Yorkshire. The entire distance will be carried over or under all the present roads, and there will be exits and 2-level junctions with some of the more important secondary highways.

Each section of the motorway will be 36 feet wide, generally laid to a depth of 2 feet over 6 inches of compacted stone base. On this will be put a 14-inch layer of either lean concrete or waterbound macadam, according to the availability of material. On top will be a 2½-inch-thick tar macadam base course and a 1½-inch asphalt wearing layer. (The portion south of St. Albans will be of 11-inch-thick reinforced concrete automatically spread in 24-foot-wide strips over a 7-inch-deep granular filling.)

Over the distance, there will be 150 bridges, including those over railroads, rivers, canals and secondary roads. There will be a 575-foot bridge over the River Nene, Northamptonshire, and 450-foot passes over the Great Ouse and River Ousel, Buckinghamshire.

More than 90 percent of the superhighway will have a grade of less than 1 to 50. This will require the moving of 14 million cubic yards of earth from the high sections to fill the lower ones. Wherever possible, topsoil will be retained for fill between the two lanes for planting areas.

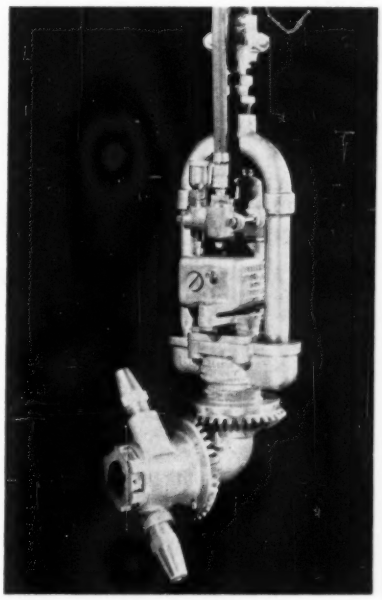
For long earth hauls, rubber-tired scrapers carrying 20 to 30 tons of earth, or 18 to 25 cubic yards, will be used. Elevator-loader excavators, fitted with plough blades, will feed conveyor belts, transferring the earth to dump trucks. For shorter hauls, track-type excavators will be used.

A special Landscape Advisory Committee has been formed to supervise the planting which is to be designed to harmonize with the surrounding country, some of England's finest. Like many of the superhighways in the United States, there will be service areas at points along both sides of the highway. These will be placed at about 12-mile intervals as the need for them arises. They will be circular in shape, divided into halves by the motorway. Each half will be connected with the other by a footbridge. The areas will include such facilities as gas stations, parking areas, picnic sites, cafeterias, restaurants and telephones.

ROTOR JET

FOR cleaning the inside of tanks, tank cars and the like, without consideration of capacity or shape, Sellers Injector Corporation has developed a device called Rotor Jet. Its operation is completely automatic; personnel need never enter the tank. This is of special importance where toxic or explosive vapors are present. The Rotor Jet is balanced so that it can be lowered into a tank and go into action being suspended by nothing more than its hose. Then, without further attention, it hydraulically scrubs every square inch of the tank's surface.

During the cleaning cycle, a rotating head directs two, solid, high-impact, hot or cold liquid jets in a full spherical path. Its rotation speed is controlled by compressed air, independent of the pressure or velocity of the hydraulic cleaning stream. A pressure of 5 psig at 5-10 cfm is required and can be drawn from shop air lines or a small compressor. The rotation speed is adjustable, a single cycle lasting from 10 to 30 minutes. Discharge capacities range from 600 to 4000 gph.



ROTOR JET

Bevel gears rotate the head of the cleaning unit illustrated here. Rotation power is controlled by compressed air at a pressure of 5 psig and at a rate of 5-10 cfm, independently of the cleaning fluid that is being shot out in the 360-degree cleaning pattern.

Something About Expositions

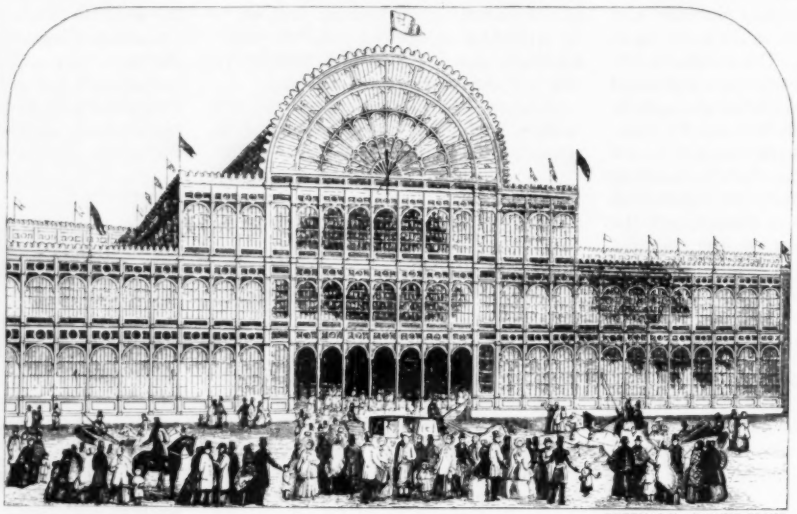
EXHIBITIONS are not as old as might be first thought. Early man had fairs and bazaars, but these were brief and of limited scope. An exhibition, or exposition, is an organized display of science, industry and art that reflects human progress throughout the greater part of the world. Through the years, two major traditions have evolved: many buildings replaced the use of a single, large one; and each show has had what might be termed a "symbolic structure."

Expositions have increased in frequency and size as a result of the industrial revolution, there being little need for them prior. The first was opened in London on May 1, 1851, and occupied a 19-acre site. Like all that were held during the immediately ensuing years, it was in one building—the Crystal Palace. Designed by Sir Joseph Paxton, the 64-foot-high structure was 1851 feet long and 408 feet wide. Because of nineteenth-century improvements in metallurgy, iron and steel were cheaper and of better quality than they had previously been, and Sir Joseph took advantage of them as both decoration and structural mediums. The Crystal Palace, erected in Hyde Park at a cost of approximately $4,000,000, was basically an iron frame sheathed in glass. The building was moved to the Sydenham district in 1854 where it remained until destroyed by a fire in 1936.

In 1855, on a 24-acre site along the Champs Elysees, Paris played hostess in the Hall of Industry to 24,000 exhibits. This single building was fabricated of white stone in a classical style. Seven years later, the gardens of the Horticultural Society at South Kensington became the setting of England's second universal fair, and another huge building, this one of brick with two large cupolas of glass furnishing its illumination.

Constantly increasing numbers of participants and visitors caused congestion in the shows that followed. Some host countries offered display space in buildings apart from the principal one, but exhibitors were not receptive. The Paris 1867 Universal Exhibition was the first to approach the multibuilding fair. From a central structure, sectors radiated over a 189,000-square-yard oval site, each reserved for a different participant. Intersecting these radii were a series of concentric rings, each reserved for a different product.

Still there was not enough space; and in the exhibitions that followed, the number of buildings increased. Today, wherever possible, one structure is reserved for each participating nation. The New York World's Fair of 1939-40 required some 62 buildings on its 1216-acre site; the current Brussels Exposition has somewhat fewer buildings.



BETTMANN ARCHIVE PRINT

London Exposition, May 1851

The second major tradition, that of "symbolic structures," was born with the 1889 Paris Exhibition and its Eiffel Tower. This 984-foot-high, 7300-ton iron framework required 2 years to erect, even though advantage was taken of contemporary advances in steel and iron bridge construction. The exhibition buildings that once surrounded the tower were enormous, with many of them resembling the Crystal Palace in their use of glass. Indeed, fair architecture had reached what might well be called "the grand scale."

America's World's Columbian Exposition, held in 1893 at Chicago, Ill., is noteworthy for its freedom of scope and grandness of scale that influenced future fair planners and designers, as well as commercial and residential architects throughout the world. Daniel H. Burnham and a commission of architectural firms worked over an undeveloped 666-acre plot, designing not only the buildings, but pieces of sculpture and the surrounding landscape. The result was a classical grace and dignity, typified by uniform cornice lines and ornamental portals. Most of the 150 buildings were fabricated of "staff"—a composition of plaster of Paris and jute fiber that produced a white-marble effect.

One of the more important features of the Chicago exposition was the development of that phase of exhibition architecture in which foreign and state buildings were designed in a spirit of nationalism. Many looked like typical structures of the homeland of the participant: Virginia's building resembled Mount Vernon; Spain's, the Convent of La Rabida; and England's, a manor of the sixteenth century. This individualism gained in popularity and was especially evident at the New York World's Fair and is, at the Brussel's Exposition.

The years 1901, 1904 and 1915 saw universal exhibitions in Buffalo, N.Y., St. Louis, Mo.; and San Francisco, Calif., respectively. At the first, expanding developments in the field of electricity resulted in unique and unusual effects of illumination—still of prime consideration today. Buildings became larger during the St. Louis event. They were positioned along lagoons, drives and gardens, each being integrated to the whole for an over-all artistic expression. The third, the Panama Pacific International Exposition, was designed by Edward H. Bennett, and is said to be the first to give professional status to exposition design engineers. Color became an important device to unite the variety of architectural schools represented. The development of this use of color reached its ultimate at Chicago's Century of Progress, in 1933-34.

Working under the direction of Daniel H. Burnham, Jr., the Century of Progress made a clean break with many exhibition traditions. There was little dependence on plaster ornament and decoration; an emphasis on simple planes, color and functionalism took its place.

Consideration was given to the exhibitors by making color and architecture a setting for their displays, advertising and merchandising. Artificial illumination had become so well developed that many of the buildings were windowless, thus increasing the exhibition space and keeping the effects of the displays constant. Comfort, safety and movement of the some 28 million spectators was also of prime consideration in the basic plans. Burnham's efforts in these fields became the basis of not only the 1939-40 fair in New York, but the event in Brussels.

In designing the Flushing Meadow Park site on Long Island, Grover Whalen, the New York World's Fair director considered function above all. Knowing the success of his work, Baron Moens de Fernig discussed with him the Brussels fair in the initial planning stages. Thus, the traditions of exposition planning were passed on to, and improved by, the Belgians.

At the New York show, a large plaza was placed at each of the many entrances to the grounds, and from these, broad avenues led to the symbolic structure —the 720-foot-high trylon and its companion 108-foot-diameter perisphere. The same grounds approach was used at Brussels, where ten entrances and boulevards lead to the Atomium. At the latter show, the more than 50 buildings are positioned throughout the 500-acre Heysel Park site. The area has been divided into three principal sections: The Belgian; The Belgian Congo and Ruahda-Urundi; and the foreign and international organizations, including the City of International Co-operation.

Sixty-two foreign nations participated at New York, making it the largest exhibition held in America. New and stimulating architectural forms were everywhere, and many of the architects made use of recently developed materials and building techniques. Two of the more outstanding structures were the Swedish and Russian pavilions. The former was designed by Sven Markelius, who was the major contributor in the movement from neoclassical to functional design. His plans were the then ultimate in functionalism. The Russian building reflected a strong nationalism, resembling many large structures constructed in the Soviet Union during the 1930's. Of classical design and with the customary huge political statue on the top, its prototype was the Palace of the Soviets in Moscow. At Brussels, the same is apparent; the Russian pavilion is of large scale and contains an enormous statue of Lenin. The American buildings at the New York exhibition continued to reflect the influence of business, industry, advertising and mass consumption that had been popular at the Century of Progress.

In planning the Brussels Universal Exposition, it was decided to have each nation design its own pavilion. At first it was feared that the fervent desire among the architects to use the latest techniques and materials would result in a monotony of design. Quite the contrary happened; each reflects either a real or stylized nationalism. Generally, each shows a tendency to decentralize the structural elements over a maximum area, rather than utilize a single, huge showplace. (The most noteworthy exception is the Russian pavilion.) Glass, plastics, aluminum and ceramics, as well as many synthetic materials, have been fused to give an over-all feeling of airiness, rather than one of staid classicism. Great emphasis has been placed on modern architectural techniques, and all is functionally geared to meet the daily mass of spectators.

Although the ties with the past are evident, the importance of the Brussels exposition on future architecture is more important. It has been said that it is 20 years ahead of its time architecturally. It is anticipated that the designs will provide an impetus, not only for future exhibitions, but for commercial and industrial architecture and planning as well.

This and That

Ships May Utilize Air "Springs"

Knud Gram, a Danish naval architect, has developed a means by which compressed air may reduce ocean-going vessels' fuel consumption by as much as 30 percent. His patented invention relies on an air cushion created along the bottom of vessels that serves as a sort of lubricant to reduce the drag created between the water and the hull. The idea is not new, for just after the turn of the century, a similar project was started. It was abandoned, however, since the air was lost and the power necessary for the compressors to furnish an adequate air supply far exceeded that horsepower required to power the ship. The reuse of the air in Dr. Gram's experiments has eliminated this. The air is pumped out the bow of the ship and sucked in aft, creating a closed circuit much like the tracks on a tank or Caterpillar tractor. It is thought that if the air is circulated at the same speed at which the ship is traveling, it will form a ½-inch-thick film; and the power required to supply it should be but 0.001 of the total horsepower required to power the vessel. Unlike track-type land vehicles, both longitudinal and a transverse current will be provided. Thus the lubrication will be effective even though the ship rolls with the waves. The device has been tried only on model ships, but from evidence derived from his models, Dr. Gram believes that when perfected, the air cushion will be applicable to all types of ships.

★ ★ ★

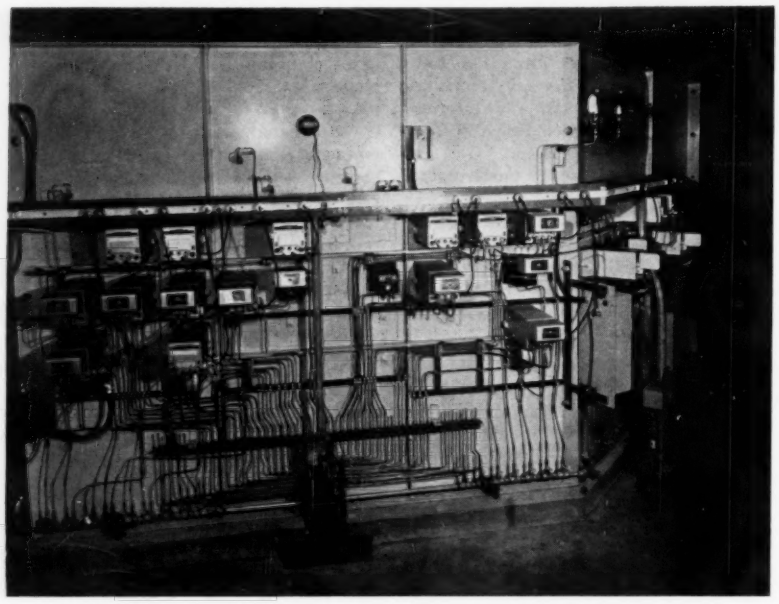
Peaceful Use For A-Bomb

Former Chairman L. L. Strauss announced that the Atomic Energy Commission is initiating field studies to determine the feasibility of an important application of nuclear explosives for peaceful purposes. These studies, a part of Project Plowshare, will investigate the practicability of excavating a harbor in northwestern Alaska between Cape Seppings and Cape Thompson, north of the Arctic Circle. The absence of harbors on the northwest coast of Alaska has hampered development of important mineral deposits. Fishing in the area has also been impeded by lack of a safe haven. United States survey parties, including personnel from the University of California Radiation Laboratory, will visit Alaska this summer to obtain detailed cost, topographical, geological and oceanographic data. Checks will also be made to assure that such an operation would be safe for people, fish and wildlife in, and near, the area. If it is found that the project is both safe and practical, the work could be performed in 1960. The AEC has been carrying forward Project Plowshare for the past year in an effort to discover nonmilitary uses of the explosive power of nuclear weapons. Besides the study of its use in moving large masses of earth and rock, the project has looked at schemes for the extraction of petroleum from low-grade deposits, the production of heat and power and the mass production of isotopes.

★ ★ ★

Training Technical Secretaries

As an answer to a too-often overlooked problem in the critical science-technology race with Russia, Washington, D.C., has announced a "crash" training program to develop technical secretaries for scientists and engineers. Called TESTS (Technical-Engineering-Scientific Training for Secretaries), the program is a special, accelerated, 90-week course to be offered by leading independent business colleges across the United States. Newly written textbooks cover the major engineering and scien-



NYLON CONTROL TUBING

Color-coded Plaskon nylon tubing is used in an instrument-air control panel installed at Allied Chemical's phthalonitrile plant at Edgewater, N. J. It is the first such system to utilize nylon in the automatic measure and control of liquid flow, temperature and pressure. Reportedly the application includes a 50-percent cost reduction per running foot; increased resistance to corrosion and greater ease of installation; not to mention the ability of nylon to be color coded. The system is used in conjunction with pneumatically activated measuring and control devices to register physical conditions at specific measuring points on the central control panel, providing regulation of plant process involving ammonia and other harsh chemical materials more safely than by direct measurement, and less expensively than by an electrical system. For the job, ¼-inch OD tubing with a 30-mil wall was utilized. Although the maximum working pressure is 800 psig and the bursting pressure is 1600 psig, the system pressure is only 3-15 psig.

tific fields in an easy-to-understand basic language. Special field trips are arranged to supplement these, and progressive teaching methods, using visual and audio aids, help students keep the pace. The program is flexible. For example, arrangements can be made for in-service training, and there is a special course for currently employed secretaries.

★ ★ ★

Lead Pencil Oddities

During 1957, the pencil industry in the United States made 1,450,000,000 pencils with a net value of approximately $35 million. These were sold to only 5 percent of the population, the balance of the people apparently appropriating their writing gear by devious means or receiving them as gifts. This is just one of many strange facts concerning this familiar object. For example, it is said that the modern pencil is capable of making a line 35 miles long, can write an average of 45,000 words and can withstand an average of 17 sharpenings.

Pencils are unusual even in their name. They contain no lead, and they are not really a pencil. The "lead" is actually graphite, the name being derived from the Greek *graphein*, meaning to write, and "pencil" finds its origin in the Latin *pencillum*, a little tail. The latter came into being because the first devices were fine brushes of hair or bristles. About 400 years ago, the first pencil evolved. It was a wooden tube holding a piece of graphite. About the year 1400, graphite was being used without any covering, although a short time later a cord was applied over it. It wasn't long before the graphite was held in a port-crayon, or metal holder. The physical form that we know today was developed in 1686 when the graphite was placed between strips of wood.

Contrary to popular belief, the wood surrounding the lead is not drilled to accommodate the graphite. Each is made in the form of a sandwich with the wood as the bread and the pencil and adhesives as the filling and dressing, respectively. The wood is first cut to size and then steel knives are used to cut the grooves for the lead. To maintain close tolerances, these blades, such as ones manufactured by The Wisconsin Knife Works, are made of a special DBL-2 high-speed steel produced by Allegheny Ludlum Steel Corporation. It is of the same type as that used in drills, reamers, lathes, planers, boring tools, gear cutters and the like, and contains tungsten, molybdenum and vanadium. As many as eight parallel grooves are machined into a slat that is half as thick as the finished pencil. The leads are laid into place and a second, similarly grooved slab is clamped, with adhesives, on top. After the glue is dried under pressure, the 8-pencil slab is next sliced into individual units, smoothed and given up to twelve coats of lacquer. After imprinting, they are fed into a machine that cuts a shoulder, fastens on a ferrule and forces in an eraser. Cross sections of the circular-shaped ones are kept within a tolerance of 0.0005 inch. Besides the round type, hexagonal and flat pencils are manufactured. There is one for almost every purpose, and the industry reported that it is supplying 370 different types and styles in eighteen degrees of hardness in more than 70 different colors. Yellow is by far the best seller, drawing 75 percent of the market.

★ ★ ★

Speeding Air Brake Charging

Southern Railway has reported that the movement of trains through its yards is being facilitated by a vast extension of its compressed air facilities. Instead of charging a long freight train from one end only, air is available at 1000-foot intervals along extended lines throughout the yards. More than 560 tons of extra-heavy wrought iron pipe in 2-, 2½- and 3-inch sizes has been placed along the ties. Wrought iron was used since it easily withstands vibrations from passing trains and the turning on and off of the air charging equipment. Further, a tightly adherent oxide film, which forms on the interior pipe wall, eliminates the possibility of loose scale plugging air outlets. Southern reports that trains are moved as much as 45-90 minutes faster through the improved yards. Among the facilities thus equipped are those at Chattanooga, Knoxville and Memphis, Tenn.; Cincinnati, Ohio; Charlotte, Asheville and Greensboro, N.C., and Jacksonville, Fla.

"Pennington!"

EDITORIAL

Carbon Time

CLOCKS are one of the more important types of the bewildering variety of mechanisms of our instrumented age. Time, and its passing, have always been of primary concern to man. In its inexorable procession, time alone is both a constant and a variable. It is always a consideration in the rating of industrial equipment, and even the most elementary of physics texts defines power as the *rate* of doing work.

Most of us do quite well with our everyday clocks utilizing seconds, minutes and hours. The rapidly moving age of research, however, has introduced a veritable deluge of problems relating to time: How, for example, to measure the fleeting passage of an electron when, according to theory, the very act of observation affects the speed, path and nature of the thing?

This concern with the primary atoms of the universe, however, has brought to light a basic natural clock, a built-in one, so to speak, that now enables us to delve deeply into the fascinating world of prehistory.

CARBON is an integral portion of the matter of all living things. Scientists tell us that for every square centimeter of the earth's surface there are 8.3 grams of the element in one form or another. To this reservoir of carbon is added, each second, 2.4 grams of the radioactive isotope carbon-14, produced by the action of cosmic rays on the nitrogen in the atmosphere. Every second, 2.4 atoms of carbon-14 are taken from this pool by their disintegration to nitrogen-14. Thus, a system in equilibrium exists in which there is no discernible change.

Scientists tell us that there are many reasons to believe that the level of cosmic ray irradiation of the earth has not appreciably changed in many thousands of years, and thus that it is reasonable to assume that this steady-state condition has existed at essentially the same rate both of inflow and outflow of carbon-14. This is the basis of one of Nature's built-in clocks. The "telling of time" with the clock depends on a fact of life. When any organic thing is alive, it is part of the carbon reservoir and is in equilibrium as far as the carbon/radiocarbon ratio is concerned. When death occurs, however, the ingestion of additional carbon-14 in food, water and air ceases, but the decay or disintegration process continues. By determining the difference in specific radiocarbon activity in a dead body with the norm (2.4 disintegrations per second per 8.3 grams) and applying the known half-life (5600 years) of carbon-14, the approximate date of death of any organic material can be determined.

CALCULATING dates with radiocarbon methods seems to correlate satisfactorily with known events of history. The error grows, of course, with the age of the sample, but in general the approximate century of death can be pinpointed. Such an approximation has already proved of great interest. The Babylonians had a fine calendar. Relating it to the Christian calendar has been the life-long project of some historians Briefly, the discrepancy that has caused all the uncertainty was due to the identification of a particular eclipse and amounts to some 300 years. Because there are only two or three clear-cut alternatives, the radiocarbon dating method was utilized to indicate the most likely one. A sample related to a known date on the Babylonian calendar was used, and the result agreed with the one thought most likely by scholars.

Radiocarbon dating has also established that the most recent period of extensive glaciation occurred about 11,400 years ago. From a campfire in an Iraqi cave, a piece of charcoal was dated that indicated that the fire was built some 25,000 years ago, thus extending considerably backward the estimated use of fire by man. There is radiocarbon evidence of very ancient men in South Africa and also data indicating that that area was never glaciated.

Grants from the Viking Fund (now the Axel Wenner-Gren Foundation), the U. S. Air Force, the Geological Society and the Guggenheim Foundation enabled Drs. W. F. Libbey and E. C. Anderson to carry on the basic carbon-14 research.

CARBON-14 dating has pointed the way to another "clock." This one may be of great aid in the ultimate tracing of water supplies. Tritium (radiohydrogen) is also formed by the action of cosmic rays on the atmosphere. Tritium burns to water, and falls as radioactive rain. With a half-life of 12.25 years, the amount of tritium in an underground water table indicates the amount of contact between surface waters and the underground supply. The rate of replenishment of these supplies thus can be estimated. Movements of ocean waters and the mixing of surface and very deep currents can also be determined.

An interesting sidelight that once again proves the adage about a silver lining for every cloud is that the tests of hydrogen weapons throughout the world have measurably increased the amount of tritium and thus have effectively labeled the rainfall of the atomic age. This fact, coupled with known dates of thermonuclear test series, may be of great help in more fully understanding the hydrological cycle and thus aiding man's quest for adequate water supplies.

"RIVER IN THE SEA"

A NEW "river in the sea," 250 miles wide and 1000 feet deep, has been mapped by the University of California's Scripps Institution of Oceanography and the U. S. Fish & Wildlife Service's Pacific Oceanic Fishery Investigations. Unlike the well-known surface currents that appear on maps of the oceans, this is a subsurface current. Measurements show that it is as strong as a thousand Mississippi Rivers and as swift as the Gulf Stream. It flows eastwardly along the equator for at least 3500 miles.

Under the auspices of the National Academy of Science's IGY Committee, the research vessels *Horizon* of the Scripps Institution and *Hugh M. Smith* of the Pacific Oceanic Fishery Investigations, recently spent almost 2 months at the equator. The cruise was called Dolphin Expedition. At the intersection of longitude 140 degrees west with the equator, the ships spent 22 days measuring the currents from the surface to a depth of more than 3000 feet. Only 100 feet beneath the west-flowing South Equatorial Current at the surface, Dolphin Expedition located and measured the east-flowing undercurrent.

The existence of the undercurrent has been known only a few years. A Fish & Wildlife Service vessel discovered it while studying long-line fishing, a technique originated by the Japanese and requiring that a series of fishing lines be attached to a rope several miles long which is supported near the surface by buoys. When the research vessel put out its line at the equator, it found that the line did not move westward with the surface current, as expected, but at a high speed in exactly the opposite direction. In 1952, Townsend Cromwell, then with the Fish & Wildlife Service, located the current at the equator and longitude 150 degrees west. In 1955, the Scripps Institution's Eastropic Expedition made a few measurements. Dolphin Expedition, however, was the first comprehensive study.

Using a technique developed at Scripps, Dolphin Expedition anchored a buoy in water nearly 3 miles deep at longitude 140 degrees west and the equator. Four other buoys were established 1 and 2 degrees north and south of the equator. These served as reference points for the subsequent current measurements. The equator buoy was tended by one of the vessels continuously for the 22-day period.

On the second half of the expedition, *Horizon* sailed alone eastwardly along the equator, making current measurements every 180 miles. The core of the current gradually lifted until it was approximately 140 feet beneath the surface. Santa Isabela Island, in the Galapagos Islands, sits astride the equator. To the west of Santa Isabela, the current was still traceable; to the east, it had disappeared. Thus, the current extends east to the Galapagos Islands; its core lies about 300 feet beneath the surface, becoming shallower toward the east; it is about 250 miles wide; its speed is about 3 knots. (The amount of water transported in a given time is about equal to that of the Gulf Stream as it emerges from the Straits of Florida.)

Townsend Cromwell was killed in an airplane crash in Mexico on his way to join another Scripps expedition just 3 days after the Dolphin Expedition completed its measurements of the current he discovered. His fellow oceanographers hope that the undercurrent will be called the Cromwell Current in his memory. This would follow the precedent of the great northflowing currents off western South America and California called the Humboldt and the Davidson currents, respectively.

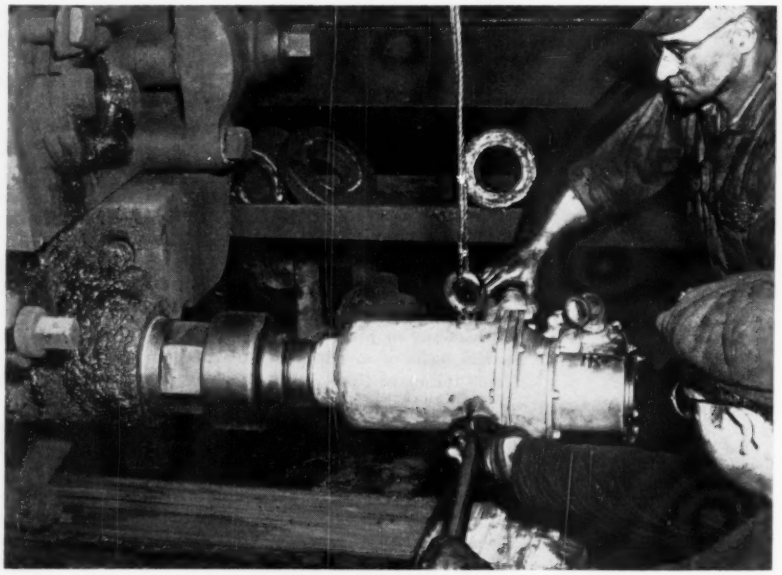
SAVING WITH AIR POWER

$2600 SAVINGS PER HOUR

THE advantages of air power over man power are evident when one reviews the history of a steel mill's problem with four 7-inch plunger stud nuts. A prominent steel plant periodically had to unscrew and replace these large fasteners which are a part of a 160-inch shear. Four men were needed and a special working platform had to be built for them. An overhead crane was occupied for 2 hours. From the time the machine was shutdown until work could be resumed, 5 hours were consumed at a cost of $650 per hour.

The solution to this expensive shutdown was Ingersoll-Rand's Size 588 Slugger air-operated Impactool. First, the mill fabricated a 10⅝-inch hex socket with 2½-inch square drive from 2-inch boiler plate. Then, a crane lifted the Impactool and the socket to a small working platform 15 feet above the floor.

Working with the Size 588 Impactool, the complete job of removing the nuts and replacing them was done in less than 1 hour. Three men instead of four did the work without the necessity of installing a special platform. The crane was in use for about half an hour, or one-fourth the previous period. Because of the decrease in down time and the reduction in the number of men required, the Slugger saved the steel company a total of more than $2600 in its first hour.



RUNNING 7-INCH STUD NUTS

This Ingersoll-Rand Size 588 Slugger air Impactool is utilized by a steel corporation for periodically removing 7-inch stud nuts from a 160-inch shear. By hand, the job took 5 hours, while the air tool does it in less than an hour, eliminating 4 hours of down time that costs the company $650 per hour.

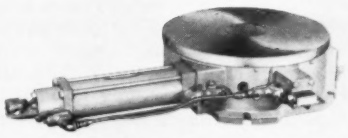
Industrial Notes

TWO MODELS have been added to Ingersoll-Rand Company's line of air-powered Impactools. The Size 5081T Torque Control Impactool is designed for applications where accurate torque control is required in the 50- to 150-foot-pound torque range; the Size 5081 Impactool is offered for running up to ⅝-inch bolts where accurate torque control is not required. Both take advantage of such advanced design changes as an air-balanced throttle valve for easy control of throttle graduation and trig-

ger pull, and muffling that reduces exhaust noises to a whisper by passing the exhaust through three expansion chambers. One-hand control is easy because reversing the tool is accomplished by shifting a small lever within reach of the thumb. The Ingersoll-Rand Torsion Bar Torque Control keeps torque constant.

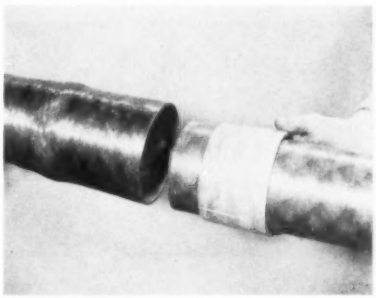
The 5081T Impactool runs at a free speed of 1350 rpm and delivers 2000 impacts per minute at 90-psig pressure. It weighs 9⅞ pounds and has an over-all length of 12 11/16 inches. The adjustable torque range is from 50 to 150 foot-pounds. When the preset torque is reached, the tool shuts off automatically. Its square driver measures ⅝ inch across flats. The 5081 Impactool, without torque control, runs at a free speed of 2000 rpm and delivers 2000 impacts per minute at 90-psig pressure. It weighs 8⅝ pounds and has an over-all length of 9½ inches. Its square driver is of the same size as that of the 5081T. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

WORK LOADS as great as 1 ton can be handled by a heavy-duty, 24-inch-diameter air-operated index table that is said to be able to withstand repetitive shock loads, both radially and axially. The manufacturer states that the unit, designated as Model No. 2400, will index 30 stations per minute when equipped for 6-station operation. Larger diameter plates may be bolted to its 1¼-inch-thick ground-steel table top when greater area is required. A 4-inch-bore air cylinder, developing a power stroke of

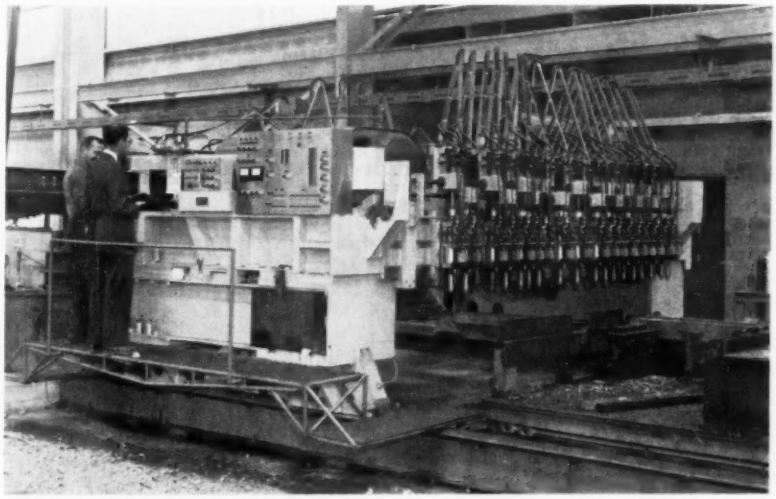


thirteen times air line pressure, rotates the unit. The table is securely locked in position by an additional air cylinder mounted on the table's centerline. Equipment used with the table is prevented from moving, until it is in locked position, by a limit switch mounted on top of the locking cylinder. The table operates on 60- to 175-psig pressure, and four, six, eight or twelve stations are standard. *Air-Hydraulics, Inc.*, 618 Hupp Avenue, Jackson, Mich.

PLASTIC pipe, that is as strong as steel with but one-eighth the weight, is manufactured in diameters ranging from 2 to 12 inches. It comes in 20-foot lengths with plain, bell-and-spigot-shaped or flanged ends. Built for in-plant piping and ducting needs, it is made from interwoven glass filaments impregnated with resins and heat cured. Bondstrand, as it is called, is said to be nonflammable and collapse-resistant, and does not cold flow or sag while in use. The manufacturer claims its smooth interior resists scale and paraffin deposits so that full flow is maintained. Two standard sizes are in production: one with a nominal working pressure of 250 psig; and the other, of 500 psig. Both are reported to have a ten-to-one safety factor. Circumferential tensile strength of the pipe is 80,000 psig, longitudinal strength is 40,000 psig. No special tools are required to cut and join the pipe, and the basic joint is



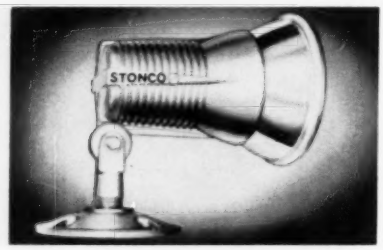
made by placing the spigot end of one pipe into the bell end of the next. An O-ring and a tapered sleeve, both secured with a special adhesive, complete the joint. Bondstrand is designed for



EIGHTEEN holes can be drilled simultaneously with a multiple drilling machine that is said to have brought automation to the structural steel and condenser plate fabricating industries. The unit will accept workpieces 12½ feet wide by 120 feet long; and holes as large as 1¼ inches in diameter can be produced. It drills through 3½ inches of mild steel in 2½ minutes. Drilling heads are air-hydraulic units, with the air being provided by an Ingersoll-Rand 3-hp, Type 30 compressor. It is said the machine's concept eliminates layout, center punching and reaming. All operations are controlled at the unit's panel by the operator, who may move the machine or the drill heads at will. The 1-man operation reduces machine time and handling costs. *Valley Engineering Corporation*, Fifteenth and Elm streets, Easton, Pa.

use with most petroleum and chemical products; sewage and industrial wastes and gases; fresh and salt water; food and pharmaceuticals; and as structural tubing and conduit. *Amercoat Corporation*, 4808 Firestone Boulevard, South Gate, Calif.

FLOODLIGHTS with patented, weathertight, floating sockets, reportedly maintain positive electric contact with all makes of reflector lamps, even under the most adverse conditions. The socket, housed in a cushion-spring cradle, adjusts automatically to variations in lamp size and shape. Excessive vibration,

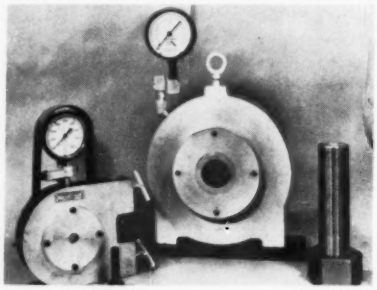


shock or pole whip, arcing, socket corrosion and water seepage—all common causes of premature lamp failure—are said to be practically eliminated. The result is an economical, all-purpose floodlight, suitable for construction sites, service stations, parking areas, gardens and the like. The lights are made for medium or mogul base reflector lamps, in 75- to 500-watt sizes. A wide variety of devices is available for pole top or wall mounting, either singly or in clusters. Each of the units is fashioned of corrosion-proof heavy-duty cast aluminum. *Stonco Electric Products Company*, 333 Monroe Avenue, Kenilworth, N. J.

A LINE of totally enclosed, explosion-proof motors, ranging in size from 1 to 500 hp, has been introduced especially for industrial applications. The motors are available in new NEMA frames through 365U, old NEMA frames through 505, and standard industrial frames above 505 through 500 hp. The line features recessed, neoprene slingers on the output shaft, a foolproof lubrication system, stainless steel connection and name plates, and shock resistant fan covers. All models have indexed leads and a balanced insulation system that is said to be impervious to moisture and corrosion. Oversize conduit boxes are standard to allow easy insulation. The design of each rating is reportedly laboratory tested to assure adequate heat dissipation from all motor elements.

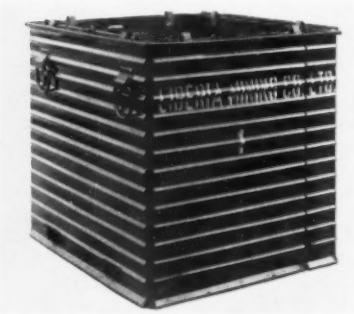
A. O. Smith Corporation, Electric Motor Division, Tipp City, Ohio.

FOR WRENCHES used with bolts to 2½ inches in diameter, Skidmore-Wilhelm has developed a calibrator, reportedly the largest ever built. To calibrate a wrench, the required size of bolt is inserted into the device and the bolt tightened. If the resulting tension, which is read directly on the gauge of the unit, is more or less than required, necessary adjustments are easily and quickly made



on the wrench. In the photograph reproduced above, an older, standard-sized model is illustrated at the left; and the new, larger one is shown in the center. *Skidmore-Wilhelm Manufacturing Company*, 442 South Green Road, Cleveland 21, Ohio.

FOREIGN cargo shipment is one major use for a collapsible, reusable steel transporter box, designed to fold into one-fifth its original size after unloading. The box is intended for 1-way shipment of material and is loaded and sent fully erected in sizes ranging from 48x48x48 to 60x60x60 inches. It is then knocked down and returned. The transporter is also said to be particularly useful in ship-

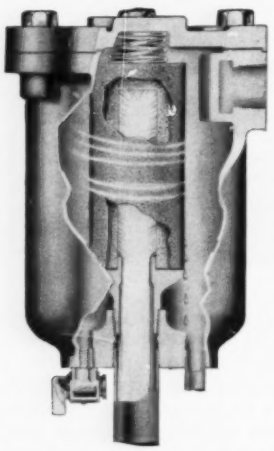


ping freight that needs protection from rough handling and pilferage. Security can be gained by attaching heavy-duty

locking arrangements. The sides of the box are fabricated from heavy corru-

ADAMS PORO-STONE AIR FILTER

designed to remove oil, water and foreign matter from compressed air lines with minimum pressure drop.



The R. P. Adams Poro-Stone air filter is engineered to efficiently remove entrained oil, water and pipe scale from compressed air lines. Liquid droplets and solids being carried by the gas stream are first removed by centrifugal action in an annular chamber. Secondary filtration is achieved by passing the air or gas stream through a Poro-stone unit. An automatic trap can be provided to discharge the residue from the cyclone chamber.

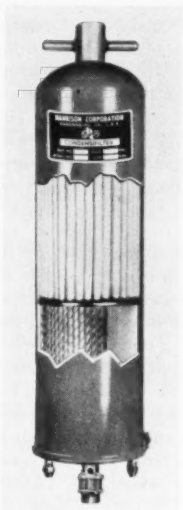
At rated capacity the filters operate at a maximum pressure drop of only ½ lb., thus insuring delivery of line pressure to the point of consumption.

The units require virtually no service or maintenance — thereby insuring continued trouble-free, low cost performance.

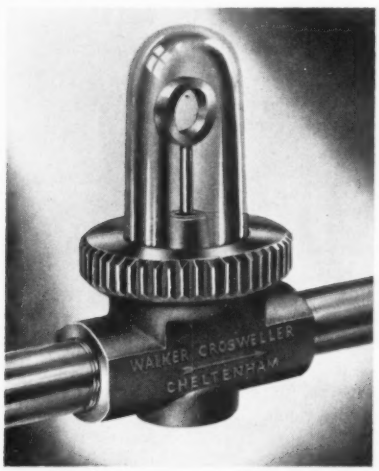
ADAMS Poro-Stone air filters are available from stock in sizes to suit your needs. For further information, write today for Bulletin 117, R. P. Adams Co., Inc., 209 East Park Drive, Buffalo 17, New York.

gated steel; welded brackets hold steel rings that are positioned for pickup by crane hooks. *Republic Steel Corporation*, Berger Division, 1038 Belden Avenue, N.E., Canton 5, Ohio.

SEVERAL features have been added to Condensifilters, units designed for filtering and dehydrating compressed air and gases. To facilitate easier coupling to lines and eliminate need for extra fittings, both inlet and outlet connections now are 1½-inch NPT on Model M-100, and 1-inch NPT on Model M-30. Model M-100 has an expanded metal separator in its condensing section to keep condensates and entrainments from contacting the filter cartridge. A guide-latch has been installed between the shell and bottom plate of all models to simplify reassembly after cartridge inspection. *Hankison Corporation*, College and Pike, Canonsburg, Pa.



FLOW of cooling water to compressors, condensers and engines is signaled with a simple, reliable safety device. A



chromium-plated ring, spinning within a toughened glass dome, shows definite movement, even at a distance and in poor light. The safety signal can also indicate flow of lubricating oil to bearings, gear trains and other moving parts. The unit can be adjusted in the field to high or low range and is available with die-cast brass body in ½-, ¾- and 1-inch pipe sizes, for flows from 0.075 to 24 gpm. Other models are available for movements of 0.075 to 120 gpm, in pipe sizes up to 3 inches. *McIntosh Equipment Corporation*, Walker Crosweller Division, 15 Park Row, New York 38, N.Y.

CONTROL of high-pressure corrosive gases and fluids is the purpose of a 2-way stainless steel solenoid valve manufactured by Atkomatic. The device is rated to 6000-psig pressure and designed for use with any medium. It is a direct lift-type unit. Designated Series 2000 and available in ⅛-, ¼-, ⅜- and ½-inch pipe sizes, the fixtures can be supplied with an explosion-proof housing.

Extra tight construction is also available where positive, leak-proof operation is required for such gases as hydrogen and nitrogen. *Atkomatic Valve Company, Inc.*, 545 W. Abbot Street, Indianapolis 25, Ind.

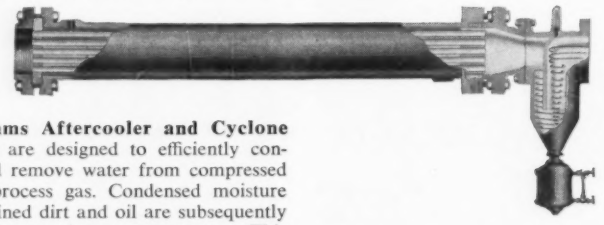
TOOL suspension and air supply are combined features of a hose reel that is said to keep air tools always within reach and save time on high-speed production. Spring tension of the reel counterbalances the weight of air-operated drills, screwdrivers and the like. A spring motor provides automatic intake of the suspended hose to the tool; tension can be adjusted by adding or removing the coils of hose. The reel is easy to install and occupies little space. Its universal mounting enables it to be attached at most plant locations. The reels reportedly can be used wherever compressed air is used with blow guns, spray guns, tire inflators, grease guns, grinders, etc. Two models handle ¼- and ⅜-inch-diameter hose. *A. Schrader's Son*, Division of Scovill Manufacturing Company, Inc., 470 Vanderbilt Avenue, Brooklyn, N.Y.

CONVEYOR BELT users may find a slide card called *Conveyor Belt Trouble-Shooter* useful. This pocket-sized device provides a quick method for locating the probable causes of conveyor difficulties and lists specific methods of eliminating the trouble. It may be obtained by writing on company letterhead to the manufacturer. *Conveyor Products*, Mechanical Goods Division, United States Rubber Company, Passaic, N. J.

VALVAIR has announced a line of Speed King, plug-in-type, ¼-inch, 4-way control valves designed for automatic connection of electrical circuits, with either a-c or d-c current and with any voltage. Installation and maintenance are said to be considerably reduced: plugs and connectors complete all electrical circuits automatically when the unit is in mounting position; and permanent wiring connections, placed in the subbase at the time of original assembly, need not be disturbed during in-service maintenance These units can be used to control small devices, and are

Aftercooler and Cyclone Separator designed for cleaner, dryer compressed air

R. P. ADAMS CO., INC.
209 East Park Drive, Buffalo 17, New York

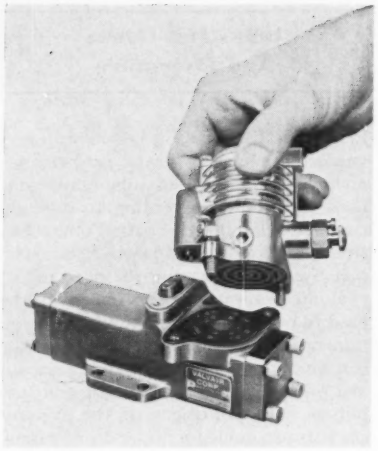


The Adams Aftercooler and Cyclone Separator are designed to efficiently condense and remove water from compressed air and process gas. Condensed moisture and entrained dirt and oil are subsequently removed in a cyclone type separator. This unit is scientifically designed for maximum removal efficiency over a wide range of flow rates.

For normal use, units are available to cool gases to within 10° F of the temperature of the cooling water. Specially designed units are available to permit a 2° F approach to cooling water temperature, for application where low moisture content is critical.

Adams Aftercoolers and Separators are available from stock to handle 20 - 40,000 cfm with 10° cooling and 25 - 19,200 cfm where it is necessary to cool within 2°F of the cooling water. Special units can be supplied to suit an unlimited range of requirements. In all cases the maximum pressure loss at rated capacities is ½ psi.

This wide range of sizes enables the economical utilization of Adams Aftercoolers and Separators in virtually all industrial application. For further information on how R. P. Adams' units will solve your compressed air problems and save you money, write today for Bulletin 711.

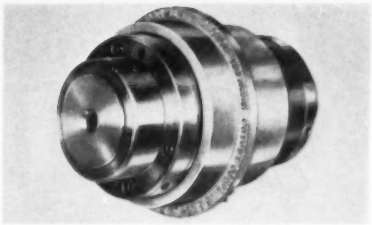


available in both single- and double-solenoid types. They have incorporated bronze bodies, stainless steel end caps, chrome-plated stainless steel stems and standard Speed King O-ring packers, and are designed for 30- to 250-psig air pressures. *Valvair Corporation*, 454 Morgan Avenue, Akron, Ohio.

GREATER LIFTING capacity is achieved with a crawler-mounted 30-B heavy-duty crane, which has main operating functions that are air controlled. The unit uses the same upper construction as the 30-B transit crane, and has long, wide crawler frames and axles that are said to provide stability and sturdiness. Its standard crawler treads are 30 inches wide; 36-inch ones are optional. The crane's 2-section, welded lattice-

type boom is 40 feet long, and its sections are joined with single-bolt, butt-type machine joints. Special boom-pin connection lugs are available as optional equipment for rapid change of boom lengths. Three boom-point sheaves are furnished, while for longer booms, 5-, 10-, 20- and 30-foot inserts are available. A spring-cushioned, telescoping boom stop is standard equipment. The standard single-sheave 15-ton crane hook block is designed for 2- or 3-part hoist lines, but special blocks available can mount as many as six lines. *Bucyrus-Erie Company*, South Milwaukee, Wis.

OVERLOAD protection, increased misalignment capacity and ease of maintenance are said to be the features of a cut-out coupling. Its power shutoff action at the time of dangerous overload is useful for equipment having power transmitted through two in-line shafts and where torque limitation is necessary. The increased misalignment capacity provides for slight parallel misalignment, angular misalignment or a combination of both. Increased stresses and



loads on the connected equipment caused by inaccurate alignment can be prevented by careful installation of the coupling. The unit works regardless of direction of rotation. *John Waldron Corporation*, New Brunswick, N.J.

Industrial Books And Literature

PRESSURIZATION is effective in preventing arcing and erratic performance of high-power vacuum tube equipment used in aircraft, according to a study completed for the U. S. Air Force. Entitled *Electronic Equipment Pressurization Systems Study*, the 302-page report evaluates various systems that might be used to pressurize sealed equipment containers and replenish air lost from the containers by leakage through mechanical seals. The data presented on capabilities and limitations of the systems constitute a guide for designing a system, or combination of systems, for a particular aircraft. These basic pressurizing sources are considered: turbojet compressor bleed, auxiliary compressors, ground-charged high-pressure storage containers, and the pneumatic systems installed in aircraft. The study is designated PB 131713. Cost, $5. *Office of Technical Services*, U. S. Department of Commerce, Washington 25, D. C.

SAFETY and relief valves are the subject of a test code recently published by the American Society of Mechanical Engineers. The code provides recommended procedures for testing valves handling air and other gases, steam, and liquids in such states that flashing will not occur. A separate section is provided for each medium. Spring-loaded, weight-loaded and pilot-operated valves are included, and only tests in which the discharge is at atmospheric pressure are considered. The purpose of the code is to establish rules for determining one or more of the following: relieving pressure, relieving capacity at the relieving pressure, theoretical relieving capacity, coefficient of discharge, start-to-leak pressure, opening and closing pressures, seal-off pressure, blowdown, reproducibility of valve performance, and mechanical

"*Must* you guys drill such big blast holes!"

characteristics of the valve as determined physically. The code, *Safety and Relief Valves*, is copiously illustrated, and also contains seven tables for pipes of various diameters. Cost, $2.50. *American Society of Mechanical Engineers*, 29 West Thirty-ninth Street, New York 18, N. Y.

A WALL chart for shop use as an aid to the selection of the proper saw blade for specific jobs lists the various sawing factors affecting cutting rate, tool life and finish. The chart shows the steps to proper blade selection and methods used to control these sawing factors for job requirements. It recommends cutting rates for carbon and high-speed-steel saw bands in relation to material work thickness as well as the saw pitch and lubricants to be used and the proper tool velocities for cutting 48 metals ranging from alloy steels to nickel-base and titanium alloys. *DoAll Company*, Des Plaines, Ill.

GEC-1260C is an 88-page publication covering the G-E line of control devices. Selection charts provide quick choice of the proper starter, heater and push-button station for any type of enclosure. Illustrated, the catalogue has guide-form specifications for easy designation of controls by distributors, contractors or architectural designers. *General Electric Company*, News Bureau, Schenectady 5, N. Y.

AIR line filters, regulators and lubricators are described in a 20-page catalogue. Complete engineering and operational data, including performance characteristics, "quick sizing" charts and specifications to save designers' time, are also included. *Watts Regulator Company*, Industrial Division, Lawrence, Mass.

REFERENCE material for three engineering fields—civil, electrical, mechanical—is included in a handy 396-page manual, *Lefax Engineering Formulas and Tables*. Basic formulas, design data and tables are indexed by twelve celluloid-tabbed dividers that give quick access to information desired. Sections include mathematics; measures; materials; gauges, screws, etc.; mechanics; electricity and magnetism; hydraulics; structural data; reinforced concrete; pipe and fittings; steam tables; and mathematical tables. All sections are printed on 6¾ x 3¾-inch pages in loose-leaf form, allowing individual sheets to be added or withdrawn without disturbing the remainder of the contents. The manual has a sturdy and pliable binder that makes for a long service life in either the field or the office. A 2-pin binder is also

available. Costs, respectively: $4.75 and $2.75. *Lefax*, Sheridan Building, Ninth and Sansom, Philadelphia 7, Pa.

MARKINGS for identifying grinding wheels and other bonded abrasives is the subject of *B5.17-1958*, published by the American Society of Mechanical Engineers. Designations for two new types of bonds have been added to the previous version of the standard, *B5.17-1949*; and the revision provides a standard identification for rubber-reinforced and resinoid-reinforced bonds. Abrasives detailed include segments, bricks, sticks, hones, rubs and other shapes of tools used to remove material, alter shape or size, produce a desired surface or accuracy of dimension or achieve a combination of these. Cost, $1. *American Standards Association*, 70 East Forty-fifth street, New York 17, N.Y.

BUSINESSES lacking full-time safety specialists will find *Handbook of Accident Prevention* a valuable aid. Just released in its second edition, the 93-page volume about occupational safety contains such new material as a description of radioactive hazards and ways to protect against them. The book's style reportedly makes it effective for use by key employees in small organizations. It is said that with the help of the handbook and the special agencies listed in it, any industrial operation can be a safe one. *National Safety Council*, 425 North Michigan Avenue, Chicago 11, Ill.

AUTOMATIC moisture separators, lubricators, regulators, filters and filtrators for compressed air systems are the subject of a 20-page catalogue (No. 157). The booklet explains the automatic draining of receiver tanks as well as the regulation, lubrication and separation of moisture from compressed air. Also described are the products for automatic filtration of oil, oil fumes and solid contaminants to as small as 3 microns in size. *Wilkerson Corporation*, 1645 West Girard Avenue, Englewood, Colo.

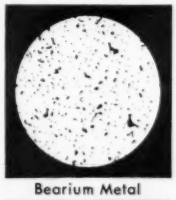
"Me?—I'm the new file clerk!"

Having Bearing Troubles Due to Poor Lubrication?

...then BEARIUM METAL is the Answer to Your Problem!

Even where water must be used as the only lubricant . . . BEARIUM METAL *does not* and *will not* seize or score the shaft. The reason is that BEARIUM METAL, because of its superior frictional properties, is *self-lubricating*. Secret of its amazing performance is due to the uniform distribution of microscopic lead particles within the copper-tin grains rather than between the grain boundaries as found in ordinary bronzes.

So, if you have a bearing requirement which calls for dependable, trouble-free performance—then by all means—BEARIUM METAL *is your best buy in bearing bronze.* Try it on one of your toughest applications and prove it to your own satisfaction.



Bearium Metal

Complete Information on Request.

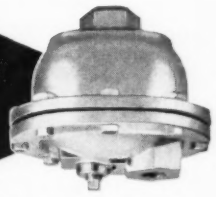
Ordinary Leaded Bronze

BEARIUM METALS CORP.
191 Mill St., Rochester 14, N. Y.

WEST COAST AFFILIATE:
Novin Engineering Associates
208 Toyopa Drive Box 536
Pacific Palisades, California

IN CANADA:
Bearium Metals of Canada, Ltd.
155 George St.
Toronto 2, Canada

THE "NO-TROUBLE" AIR TRAP



THE ARMSTRONG NO. 21 BALL FLOAT AIR TRAP — GUARANTEED TO SATISFY OR YOUR MONEY BACK

For draining moisture from air lines, (drip pockets, small separators, small receivers, etc.) you can depend on the Armstrong No. 21 air trap for trouble-free service. It's built to the highest standards—guaranteed to satisfy. Can be used wherever no heavy oil or dirt is present. Check the features:

- **No Air Loss**—valve is always water-sealed.
- **Stainless Steel Parts**—float, leverage system and valve seat. Valve is heat-treated chrome steel.
- **Small, Compact**—Simple design, with a strong, cast semi-steel body.
- **Self-Priming**—no need to add water to start operation.

Bulletin Describes Complete Line of Armstrong Air Traps

Bulletin No. 2024 shows how to select air traps for any job. Gives dimensions, capacities and prices of all Armstrong air traps. For your copy, call your local Armstrong Representative, or write:

8855 Maple St., Three Rivers, Michigan

ARMSTRONG MACHINE WORKS

---

all types of industries use

BAND-IT® CLAMPS

all over the world

Distributors in:
AUSTRALIA
AUSTRIA
BELGIUM
BELGIUM CONGO
BOLIVIA
BRAZIL
BRITISH GUIANA
CANADA
CEYLON
COLOMBIA
COSTA RICA
CUBA
DOMINICAN REPUBLIC
EGYPT
ETHIOPIA
FINLAND
FRANCE
FRENCH GUIANA
GERMANY
GUATEMALA
HAITI
HAWAII
HONDURAS
HONG KONG
INDIA
IRAN
IRAQ
ITALY
JAMAICA
JAPAN
JORDAN
KUWAIT
LEBANON
LIBYA
MALAYA
MEXICO
MOROCCO
NETHERLANDS
NETHERLAND ANTILLES
NORWAY
PAKISTAN
PARAGUAY
PERU
PHILIPPINES
PUERTO RICO
QATAR
RHODESIA, NORTHERN
RHODESIA, SOUTHERN
SUDAN
SUD VIETNAM
SWEDEN
SWITZERLAND
SYRIA
TANGIER
THAILAND
TRINIDAD
TUNISIA
TURKEY
UNION OF SOUTH AFRICA
UNITED KINGDOM
VENEZUELA

Clamps of all diameters formed from continuous roll of stainless steel band without waste . . . for a few cents and in a few seconds.

THE BAND-IT CLAMP WAREHOUSE

Holds 900 BAND-IT industrial pressure clamps in approximately 1 cubic foot of space.

Carry BAND-IT tool, band and buckles (all that is needed to form Band-It clamps) in this portable Clamp Warehouse, just like a tool kit. Makes 900 stainless steel clamps of all diameters—for any type clamping job, any shape of object. Especially useful for emergencies such as leaking pipe or hose. 1001 other uses.

SEND FOR NEW, FREE 16 PAGE CATALOG

Over 1500 Authorized Distributors in all principal cities of the United States and in 59 other countries.

BAND-IT® CO.
Incorporated 1937
4765 Dahlia St., Denver 16, Colorado, U.S.A.

BAND-IT CLAMPS GO 'ROUND THE WORLD

Ad No. 26 7-58

"Cellulubes are against fire

SAYS RICHARD A. PARKER, CHIEF ENGINEER PARKER WHITE METAL COMPANY, ERIE, PENNA.

"They also curtail corrosion . . . provide longer pump life and valve wear."

"In our hydraulic die-casting operation—involving open flame, temperatures to 1,400 degrees F, and molten metals—we consider it absolutely essential to use flame-resistant Cellulube for power transfer," continues Mr. Parker. "And with Cellulube we have no gummy valves, clogged strainers, or corroded reservoirs that characterized some of the fluids we formerly used."

This performance is typical of what you can expect from Celanese Cellulubes, which were developed to assure the safety of fire-resistance, with excellent lubricity and the dependability of unchanging operational viscosity. They are available in six controlled viscosities: 90, 150, 220, 300, 550, and 1,000 S.U.S. at 100°F.

Why not evaluate Cellulubes for your own operations? Just use the coupon to describe the application you have in mind and request technical data and samples.

Celanese® Cellulube®

CELANESE CORPORATION OF AMERICA, CHEMICAL DIVISION
DEPT. 596-S, 180 MADISON AVENUE, NEW YORK 16, N.Y.

Please send me:

☐ New Technical Bulletin "Celanese Safety Series" ☐ Sample, of_____viscosity.

Name & Title_____

Company_____

Address_____

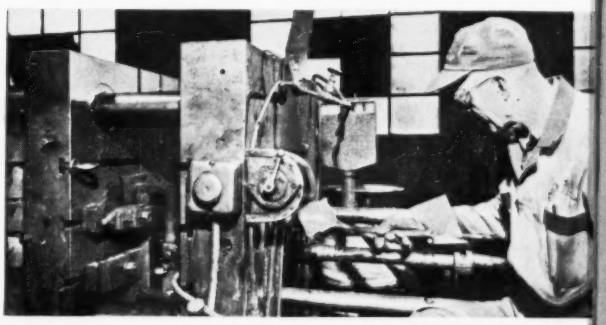
City_____ Zone_____ State_____

Application in mind_____

our insurance disaster"

BETWEEN THIS . . .

Operator ladling molten metal into the shock chamber of 400-ton die casting machine. "Given the tremendous pressures under which the hydraulic fluid forces the ram home . . . we must prepare against a possible line rupture. It is vitally important that we use fire-resistant Cellulube in this operation."

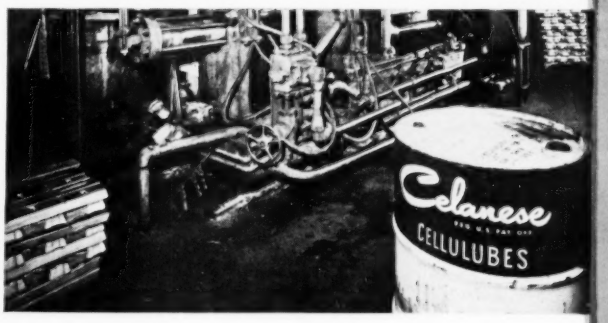


AND THIS . . .

Operator removing a casting from opened die. When the ramming operation is completed, the Cellulube is by-passed to the reservoir, ready for the next one. "Open flame coupled with leakage sometimes resulting from the tremendous pressures creates a serious hazard. Cellulube is our insurance against this hazard . . ."

. . . THIS!

Cellulube 150 is used in the Parker White Metal Company's 400- and 500-ton die-casting machines. Each machine uses 100 gallons of Cellulube. "Its performance has been completely satisfactory . . ." says Richard A. Parker, Chief Engineer.



FM

Factory Mutual-Approved
(Cellulubes 150 and 220)

Celanese CHEMICALS

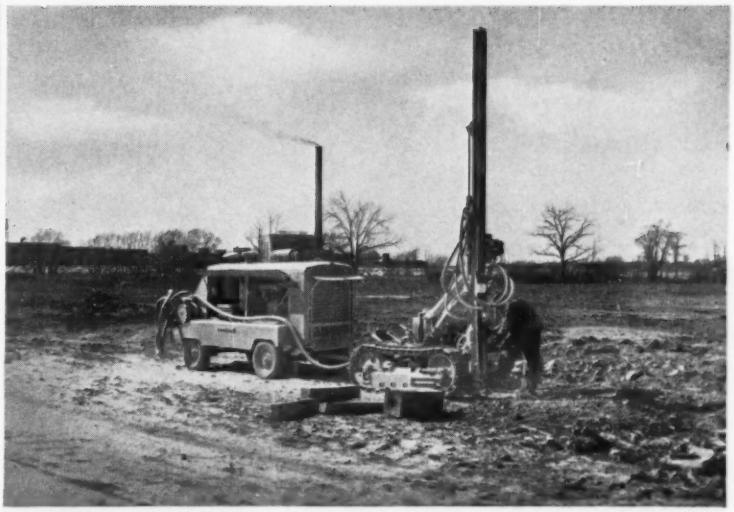
Celanese Corporation of America, Chemical Division, 180 Madison Avenue, New York 16, N.Y.
In Canada: Canadian Chemical Co., Limited, 2035 Guy Street, Montreal, P. Q., Canada.
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N.Y.

CELANESE CELLULUBES

FIVE CRACK DRILL TEAMS

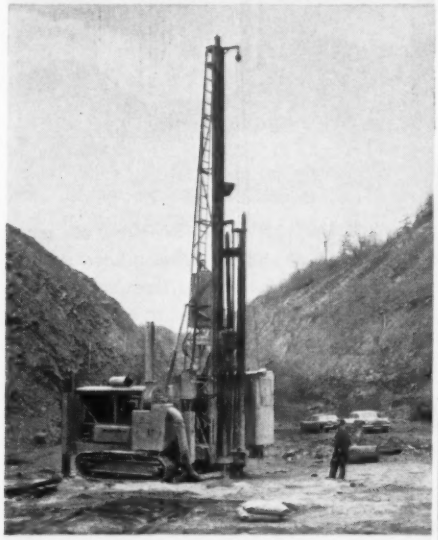
in action...

For profit-making performance,
you can't beat
I-R ROCK DRILLS
and
GYRO-FLO COMPRESSORS

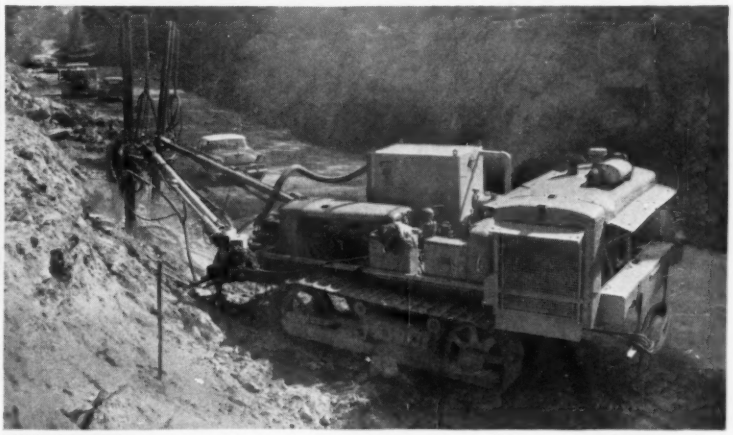


① Above: Ingersoll-Rand CRAWL-IR drill, powered by 600 cfm GYRO-FLO compressor, drilling 2½" blast holes for installation of 30" storm sewer.

② Below: Tractor-mounted HYDRA-BOOM drilling rig with 600 cfm GYRO-FLO compressor, placing blast holes for a highway reconstruction project.



③ Above: Ingersoll-Rand DRILLMASTER powered by a self-contained 600 cfm GYRO-FLO compressor, sinking quarry blast holes with the I-R DOWN HOLE drill.



④ Above: Ingersoll-Rand Crane Carrier mounted TRUCM3 DRILL-MASTER putting down 6½" blast holes for removing overburden in coal stripping operation.

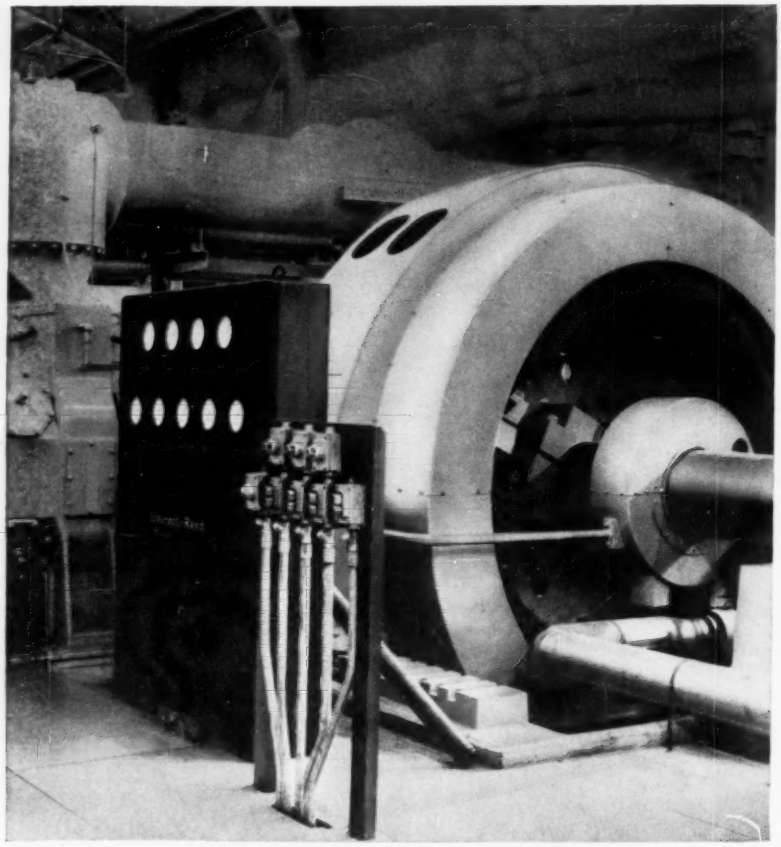
⑤ Above, Right: Ingersoll-Rand PLM3 DUAL-DRILL RIG mounted on tractor boom. The air is supplied by a 600 cfm GYRO-FLO compressor on this pipeline job.

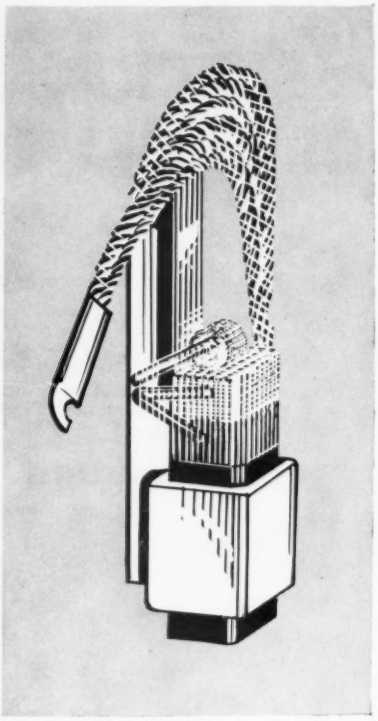
Ingersoll-Rand

14-869

11 Broadway, New York 4, N. Y.

AN UNBEATABLE COMBINATION...GYRO-FLO COMPRESSORS AND I-R ROCK DRILLS





STOP-MOTION ILLUSTRATION of new G-E brush holder shows how spring maintains constant, uniform brush pressure at all stages of brush wear.

"Constant-Pressure" Brush Holders, Improved Polyex* Insulation Increase Life; Decrease Maintenance of General Electric Motors

Here are just a few of the many advantages offered you by Polyex* ground insulation systems used in General Electric motors:

1. Longer insulation life at Class A temperatures.
2. Dimensional stability of coils due to this new insulation's "nonshrinking" features.
3. Greater chemical resistance to moisture, weak acids, dirt, etc.
4. Greater voltage endurance amounting to up to 50% improvement over previous insulation materials.
5. Corona-resistant armor, 4000 volts and above.

Polyex insulation is the most recent milestone in General Electric's continuing research for the best in insulation systems. When you select a G-E motor, you get the latest developments in design and construction.

CONSTANT-PRESSURE HOLDER

General Electric engineers have developed a new carbon brush holder that keeps brush pressure constant and *uniform,* thus eliminating the need for adjustment. This new "constant-pressure" feature effectively minimizes both brush and collector-ring wear, and offers freedom from sticking and chattering.

Since the new holder accommodates brushes with greater length than previous models, you get up to 50 per cent longer wearing length, another maintenance reducing feature.

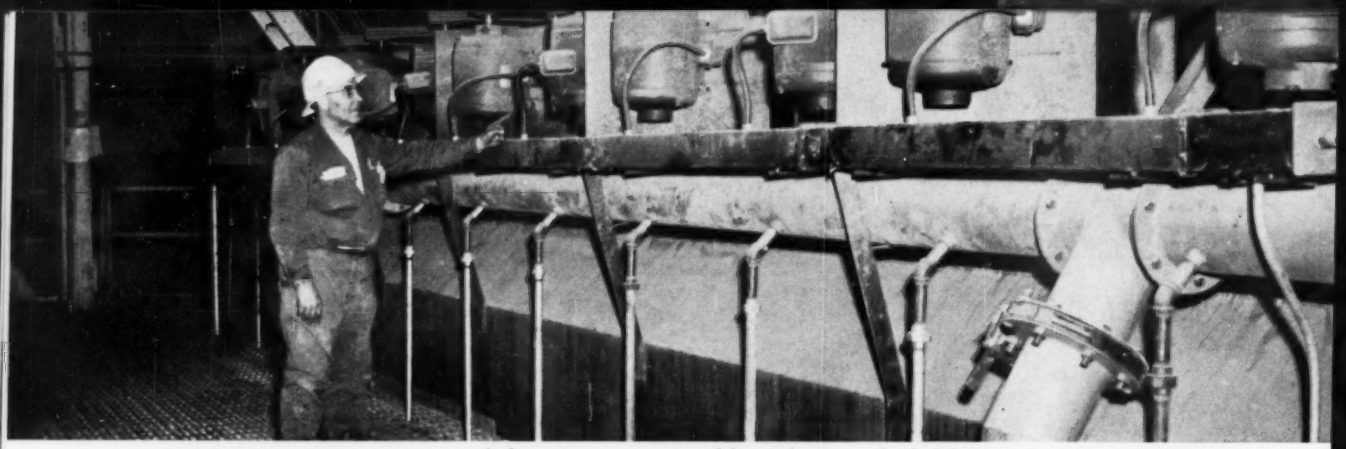
No matter what your requirements are, General Electric application engineers will help you select the right motor for your particular application from the complete line of G-E motors. For more information, contact your nearest Apparatus Sales Office, or write Section 775-9, General Electric Company, Schenectady 5, N. Y.

*Registered trade-mark of General Electric Co.

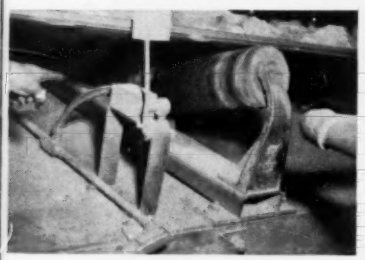
Progress Is Our Most Important Product

GENERAL ELECTRIC

ADVERTISERS INDEX

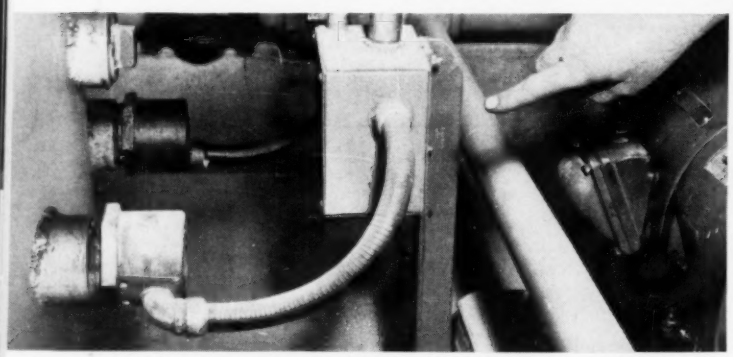


FLOTATION CELL motor connections with the raceway are protected from vibration and splash by ½-inch Sealtite conduit.

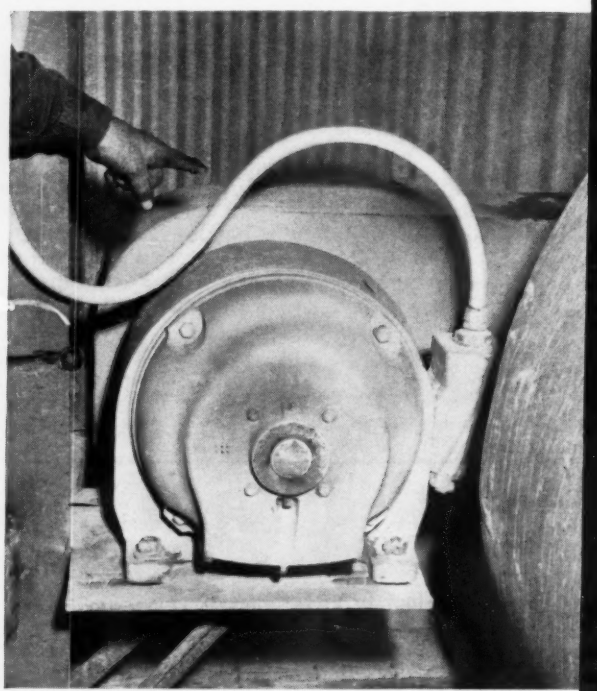


CONVEYOR side-travel switch connections are protected from spilling rock by ½-inch Sealtite.

OIL PUMP motor connections to conduit are protected from seeping oil by ½-inch Sealtite.



IMMERSION HEATER connections for Storke crusher gyratory lube oil system are protected from heat and spillage by 1-inch Sealtite.



STORKE CRUSHER exhaust fan motor connection in ¾-inch Sealtite must accommodate motor position shifts.

Nearly a mile of Sealtite flexible, liquid-tight conduit protects wiring for Climax Molybdenum*

In hundreds of vital spots, more than 4000 feet of Sealtite help keep equipment operating dependably at The Climax Molybdenum Company mine, Climax, Colo. The flexible, liquid-tight conduit guards wiring to motors and controls from the full range of underground mining and mineral dressing hazards—from rock fragments to flotation reagents, dust, oil, heat, moisture, vibration, and movement.

Electrical Wholesalers stock Sealtite. Buy it in long, random lengths on nonreturnable wooden reels, at no extra cost. Available in sturdy cartons that are easy to store and carry to the job. Liquid-tight connectors also are available from wholesalers' stocks. For information write: The American Brass Company, American Metal Hose Division, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 58185

**A Division of American Metal Climax, Inc.*

LISTED UNDER LABEL SERVICE PROGRAM OF UNDERWRITERS' LABORATORIES, INC.

CUTAWAY SECTION of Type U.A. Sealtite shows tough polyvinyl jacket over flexible metal core. Copper conductor wound spirally inside conduit gives positive ground.

insist on the conduit marked SEALTITE®

FLEXIBLE, LIQUID-TIGHT CONDUIT

an ANACONDA® *product*

Tough

Compact

Smaller

Lighter

EVERYTHING YOU WANT
IN A QUICK-CONNECTIVE PNEUMATIC COUPLING

Hansen Series RL One-Way Shut-Off Couplings will handle any job in your shop using ¾" to ⅛" connections—from the air line to the air tool. All Hansen Series 2-RL Sockets and Plugs are interchangeable with each other. Likewise all Sockets and Plugs of the slightly larger, greater capacity Series 3-RL are similarly interchangeable with each other.

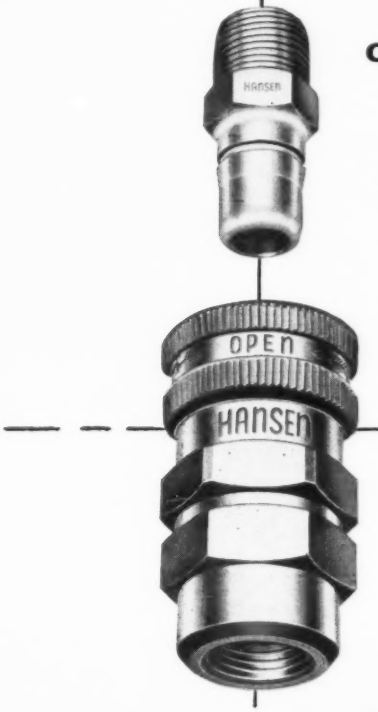
Consequently, by standardizing on either Hansen Series 2-RL or Series 3-RL Couplings, you eliminate any need for various size couplings in your hook-up—make it easy to keep stock of parts in balance—and hold inventories to a minimum.

Machined from solid steel bar stock, Plugs and Sockets are hardened and rust-proofed for long wear.

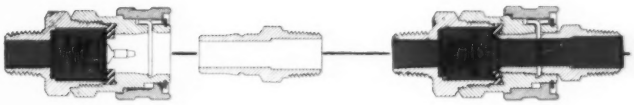
Locking ring provides positive lock and assures tight fit. Equipped with automatic sleeve lock.

THE HANSEN SERIES RL

QUICK-CONNECTIVE RING-LOCK COUPLING



Relative size of ordinary coupling required for effective handling of same volume



Blue section shows how Socket, when disconnected, automatically shuts off air by leak-proof seal of metal valve against rubber valve seat.

Connected Hansen Ring-Lock Coupling. Blue section shows free flow of air through connected Coupling.

REPRESENTATIVES IN PRINCIPAL CITIES

WRITE FOR THE HANSEN CATALOG

Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for L.P. Gas, Steam, Oxygen, Acetylene, etc.

SINCE 1915

QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • • CLEVELAND 35, OHIO

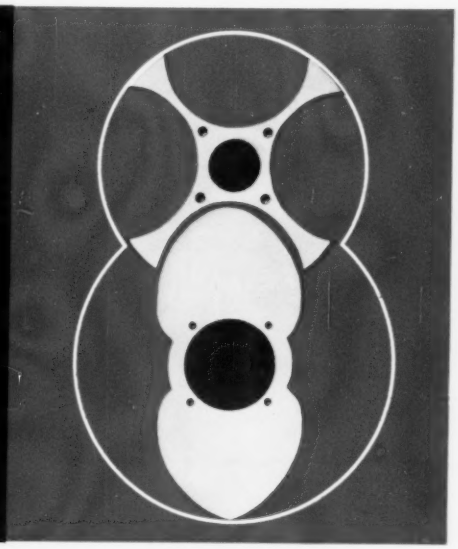
PREVENT CONTAMINATION OF AIR OR GAS

with the IR *Axi-compressor*

Unique Rotary Design
assures

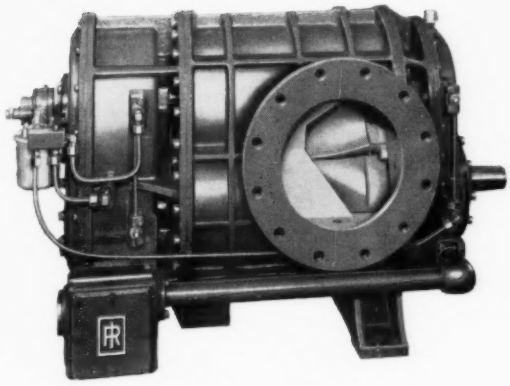
OIL-FREE
COMPRESSION

Capacity 100 - 12,000 cfm
Pressures to 15 psig
Vacuums to 15" Hg.



IN THE Ingersoll-Rand Axi-compressor, there's no possibility of contaminating air or gases with oil, because there is *no lubricant* in the compression chamber. The two helical rotors operate with close clearances—but they never touch each other and never touch the casing. Hence there's no need for any internal lubrication.

The rotors are synchronized by timing gears, encased in a separate, oil-tight compartment. Shaft seals between the compression chamber and atmosphere are simple labyrinth type as standard. Positive, mechanical type seals are also available. This is just one of several basic advantages of the Axi-compressor for compression or vacuum service. Ask your Ingersoll-Rand representative for complete information, or send today for a copy of Bulletin 11,001A.



advantages:

- **SPACE-SAVING, COMPACT DESIGN**—can be installed on simple, low-cost foundations.
- **CLEAN, OIL-FREE AIR**—no danger of contamination from lubricants.
- **SMOOTH, PULSATION-FREE COMPRESSION**—no bulky air receivers required.
- **OPERATES AT HIGHER MOTOR SPEEDS**—can be direct driven without belts or gears.

Ingersoll-Rand

17-848 11 Broadway, New York 4, N. Y.

PUMPS • CENTRIFUGAL & RECIPROCATING COMPRESSORS • DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • STEAM CONDENSERS